AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

BY

MRS. GRACE J. LIVINGSTON.

Reprinted from MONTHLY WEATHER REVIEW for June, September, and November, 1908, and February, March, April, May, and June, 1909.

Reprinted from MONTHLY WEATHER REVIEW for June, September, and November, 1908, and February, March, April, May, and June, 1909.

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.[1]

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

INTRODUCTION.

The aim of the bibliographer has been not merely to give a list of the titles of publications bearing on or referring to the subject of evaporation, but to set before the reader a sufficiently full summary of each reference, so far as it has been accessible, so that the actual work need not be consulted except in cases where the fullest information is required. Articles bearing on the subject from the point of view of the meteorologist, the agriculturist, the irrigation and hydraulic engineer, have been included wherever found. Hygrometry, however, has been regarded as a distinct subject and only articles which deal with the subject in a general way, or which relate it in any way to the measurement of evaporation have been included. Evaporation from plants, or transpiration, has not been specifically included, as that subject has been so thoroly reviewed by Burgerstein, Transpiration der Pflanzen.

The subject thus restricted has been interesting, mainly historically, as showing a development similar to that in all sciences, from the theoretical and vague to the experimental and definite. Until the beginning of the nineteenth century the attention of men of science was centered almost entirely on philosophical discussions of the physical nature of the phenomena. There were, with one or two exceptions, no attempts to devise instruments for actually measuring the rate of evaporation which might be expected under given conditions, or for relating the amount to other measured phenomena. Dalton, at the very beginning of the nineteenth century, may be regarded as the first to give definite direction to the interest already aroused in this subject, and by his researches to have laid the foundation for all future work along this line. The impetus thus furnished, fostered in the latter half of the century by such an enthusiast as G. J. Symons, has lasted to the present time. The simple laws which he pointed out have been the starting point for all the work undertaken by later mathematicians who have attempted to show definite relations between evaporation and the meteorological elements which influence and determine it.

The bibliographical study has been interesting secondarily as showing the actual degree of knowledge which has been obtained regarding the subject in all its relations, and finally as pointing out the direction in which further investigation must be conducted in this "most desperate branch of the most desperate science, meteorology."

---

[1] This bibliography is published at the urgent request of many investigators who have examined the manuscript. It has not been practicable to verify all the formulas and references nor to insert any illustrative figures.—*C. A.*

Acknowledgments are gratefully extended to the officials of the Library of the Weather Bureau at Washington, D. C., and of John Crerar Library at Chicago, where this work has been mostly pursued, for their courtesy in granting free access to their shelves. For the inspiration of the work and for the use of a MS. bibliography of this subject including titles up to 1884 the bibliographer is deeply indebted to Prof. Cleveland Abbe, the Editor of the MONTHLY WEATHER REVIEW.

LIST OF ABBREVIATIONS FOR TITLES OF PERIODICALS.

Amer. jour. sci.	American journal of science. New Haven, Conn.
Amer. met. jour.	American meteorological journal. Boston, Mass.
Amer. nat.	The American naturalist. Boston, Mass.
Ann. agron.	Annales agronomiques. Paris.
Ann. chim. et phys.	Annales de chimie et de physique. Paris.
Ann. école nat. agr. Montpellier.	Annales de l'école nationale d'agriculture de Montpelier. Montpellier, France.
Ann. inst. met. Roumania.	Annales de l'institut météorologique de la Roumanie. Bucharest.
Ann. Landw.	Annalen der Landwirtschaft in den preussischen Staaten. Berlin.
Ann. ofic. met.	Annales de la oficina meteorologica Argentina. Buenos Aires.
Ann. Phys.	Annalen der Physik. Halle.
Ann. Phys. und Chem.	Annalen der Physik und Chemie. (Poggendorf) Berlin; (Wiedemann) Leipsic.
Ann. ponts chauss.	Annales des ponts et chaussées. Paris.
Ann. rpt. Smithsn. inst.	Annual report of the Board of regents of the Smithsonian institute. Washington.
Ann. sci. ind.	Annales scientifique et industrielle. Paris.
Ann. soc. agr. Lyon.	Annales de la société d'agriculture, histoire naturelle, et arts utiles, de Lyon. Lyon, France.
Ann. soc. mét.	Annuaire de la société météorologique de France. Paris.
Ann. uffic. cent. met. Ital.	Annali dell'ufficio centrale di meteorologia italiana. Turin.
Anz. k. Akad. Wissen. (Wien.)	Kaiserliche Akademie der Wissenschaften. (Wien.) Mathematisch-naturwissenschaftliche Klasse. Anzeiger. Vienna.
Arch. med. Aarau.	....
Arch. sci. phys. et nat.	Archives des sciences physiques et naturelles. Geneva.
Athen.	Athenaeum. London.
Atti. accad. pont. nuovi Lincei.	Atti del l'accademia pontificia dei nuovi Lincei. Rome.
Atti r. accad. Lincei.	Atti della reale accademia dei Lincei. Rome.
Atti soc. veneto-trentina sci. nat.	Atti della societa veneto-trentina di scienze naturali. Padua.
Bayer. met. ephem.	Königliche bayerische Akademie der Wissenschaften. Meteorologische Ephemeriden. Munich.
Bibl. ital.	Biblioteca italiana. Milan. (ossia giornale di letteratura, etc.)
	Biblioteca italiana, ou Tableau des progrès des sciences et des arts en Italie. Turin.
Bibl. univ.	Bibliothèque universelle de Génève. Geneva.
Bol. soc. geog. Lima.	Boletín de la sociedad geográfica de Lima. Lima, Peru.
Boston jour. phil. arts.	Boston journal of philosophy and the arts. Boston, Mass.

Brit. rainf	British rainfall. London.
Bul. acad. imp. sci	Bulletin of the imperial academy of sciences. St. Petersburg.
Bul. acad. sci. de Belgique.	Bulletin de l'académie royale des sciences, des lettres, et des beaux arts de Belgique. Brussels.
Bul. assoc. sci. de France.	Bulletin de l'association scientifique de France. Paris.
Bul. dir. agr. et com. (Tunis.)	Bulletin de la direction de l'agriculture et du commerce. Tunis.
Bul. int. de l'obs. de Paris.	Bulletin internationale de l'Observatoire de Paris. Paris.
Bul. mens. obs. phys. cent.	Bulletin mensuel de l'observatoire physique central de Montsouris. Montsouris, France.
Bul. mét. Hérault	Bulletin météorologique du département de l'Hérault. Montpellier, France.
Bul. soc. philom	Société philomathique de Paris. Annual bulletin. Paris.
Bul. soc. vaud. sci. nat.	Bulletin de la société vaudoise des sciences naturelles. Lausanne.
Carnegie Inst. Washington, Pub.	Carnegie institute of Washington. Publications. Washington.
Centbl. Agr. Chem	Centralblatt für das gesammte Forstwesen. Vienna.
Chem. Ann	Chemische Annalen für die Freunde der Naturlehre. Helmstädt, Germany.
Chem. Centbl	Chemisches Centralblatt. Leipsic.
Ciel et Terre	Ciel et Terre. Brussels.
Coll. acad. franç.	Collection académique, partie française. Dijon and Paris.
Comment. acad. sci. imp. Petrop.	Commentarii academiae scientiarum imperialis Petropolitanae. St. Petersburg.
Compt. rend	Comptes rendus hebdomadaires des séances de l'académie des sciences. Paris.
Dingler's polytech. Jour.	Dingler's polytechnisches Journal. Stuttgart.
Edinb. encycl	....
Edinb. new phil. Jour.	Edinburgh new philosophical journal. Edinburgh.
Edinb. phil. jour	Edinburgh philosophical journal, Edinburgh.
Engin. rec	Engineering record, building record, and sanitary engineer. New York.
Essays obs. phys. lit.	Essays and observations, physical and literary, read before the philosophical society in Edinburgh. 2 vols. (I, II), 8vo., Edinburgh, 1754–56. Vol. III, 1771.
Exp. sta. bul	U. S. department of agriculture, office of experiment stations. Bulletin. Washington.
Exp. sta. rec	U. S. department of agriculture, office of experiment stations. Record. Washington.
Forsch. Geb. Agr. Phys.	Forschungen auf dem Gebiete der Agrikultur-Physik. Heidelberg.
Fortsch. f. Met	....
Fortsch. der Phys	Fortschritte der Physik. Berlin.
Franklin inst. jour	Journal of the Franklin institute. Philadelphia.
Gaea	Gaea, Natur und Leben. Cologne.
Geog. Abh	Geographische Abhandlungen. (Penck), Vienna.
Geog. jour	Geographical journal. London.
Gior. fis. chim	Giornale di fisica, chimica, storie naturale, medicina ed arti. Pavia.

Gior. sci. nat	Giornale di scienze, naturali ed economiche. Palermo.
Glean. sci	Gleanings in science. Calcutta.
Hist. acad. sci	Histoire de l'académie royale des sciences. Paris.
Illus. Ztg............	Illustrierte Zeitung. Leipsic.
Izv. Moskov. Selsk. Khoz. Inst. (Ann. inst. agron. Moscou).	Izviestia Moskovskoie Selsko Khozyaistvennei Institut. (Annales de l'institut agronomique de Moscou.) Moscow.
Jahrb. tellur. Obs. Bern.	Jahrbücher des tellurischen Observatoriums zu Bern. Bern.
Jour. agr. prat.......	Journal d'agriculture pratique. Paris.
Jour. agr. sci	The Journal of agricultural science. Cambridge, England.
Jour. Amer. chem. soc.	Journal of the American chemical society. Easton, Pa.
Jour. Asiat. soc. Bengal.	Journal of the Asiatic society of Bengal. Calcutta.
Jour. Chem. Phys....	Journal für die Chemie und Physik. (Schweigger), Nuremberg, Germany.
Jour. chem. soc......	Journal of the chemical society. London.
Jour. de phys. Paris..	Journal de physique théorique et appliqué. Paris.
Jour. dept. agr. So. Aust.	Journal of the department of agriculture of South Australia. Adelaide.
Jour. Landw.........	Journal für Landwirtschaft. Berlin.
Jour. mines..........	Journal des mines. Paris.
Jour. nat. phil. chem.	Journal of natural philosophy, chemistry, and the arts. (Nicholson's), London,
Jour. Phys. Leipsic..	Journal der Physik. Leipsic.
Jour. phys. Paris.....	Journal de physique, de chimie, d'histoire naturalle et sur les Arts. Paris.
Jour. roy. agr. soc....	Journal of the royal agricultural society of England. London.
Jour. roy. geog. soc..	Journal of the royal geographical society of England. London.
Jour. Russ. phys. chem. soc.	Journal of the Russian physico-chemical society. St. Petersburg.
Jour. soc. arts	Journal of the society of arts. London.
K. bayer. Akad. der Wiss. Munich, Gelehrte Anz.	Königliche bayerische Akademie der Wissenschaften. Gelehrte Anzeigen. Munich.
L'atmosphère	....
Lotos	Lotos. Zeitschrift für Naturwissenschaften. Prague.
Les mondes..........	Les mondes. Paris.
Madras jour. lit. sci..	Madras journal of literature and science. Madras.
Mag. f. neu. Zustand Naturk.	Magazin für den neuesten Zustand der Naturkunde. Jena and Weimar.
Mag. neu. Phys. und Naturgesch.	Magazin für das neueste aus der Physik und Naturgeschichte. Gotha.
Mannheim ephem....	Societas meteorologica palatina. Ephemerides. Mannheim.
Med. repos	Medical repository. New York.
Mél. phys. et chem...	Mélanges physiques et chimiques. St. Petersburg.
Mém. acad. sci	Mémoires de l'académie royale des sciences. Paris.

Mém. inst. nat. sci. et arts.	Mémoires de l'institute national des sciences et arts. Paris.
Mem. lit. phil. soc ...	Memoirs of the Manchester literary and philosophical society. Manchester, England.
Mem. met. ital.......	Memorie meteorologica Italiana. Rome.
Mem. r. accad. Torino	Memorie della reale accademia di Torino. Turin.
Mem. reg. accad. sci. Modena.	Memorie della regia accademia di scienzi, lettere ed arti in Modena. Modena, Italy.
Mem. soc. agric. Orleans.	Société royal d'agriculture, des sciences, belles-lettres et arts. Mémoires. Orleans.
Mem. soc. ital. sci ...	Societa italiana della scienze. Memorie. Naples. Rome.
Mém. soc. sci. phys. et nat. Bordeaux.	Mémoires de la société des sciences physiques et naturelles de Bordeaux. Paris.
Met. Soc. Rep	....
Met. ital. sup	Meteorologia Italiana. Rome. Supplemento alla Meteorologia Italiana.
Met. Jahrb. Jena.....	Meteorologische Jahrbücher. Jena.
Met. Zeits	Meteorologische Zeitschrift. Brunswick, Germany.
Mitt. forstl. Versuchsw. Ost.	Mittheilungen aus dem forstlichen Versuchswesen Oesterreichs. Vienna.
Mitt. schweiz. Centralanst. forstl. Versuchsw,	Mittheilungen der schweizerischen Centralanstalt für das forstliche Versuchwesen. Zürich.
Monit. sci	Le moniteur scientifique. Paris.
Mo. weather rev	U. S. Weather Bureau, Monthly weather review. Washington.
München Sternw. Wochenbl.	Annalen der königlichen Sternwarte bei München. Wochenblatt. Munich.
Nat. geog. mag	National geographic magazine. Washington.
Nature	Nature. London.
Naturw. Abh	Naturwissenschaftliche Abhandlungen.
Neu. allg. Jour. Chem.	Neues allgemeines Journal der Chemie. Leipsic.
Neu. Hamburg Mag..	....
Notiz. Geb. Nat. u. Heilk.	Notizen aus dem Gebiete der Natur- und Heilkunde. (Froriep.) Erfurt, Weimar, Jena.
Nouv. mét....... ...	Nouvelles météorologiques. Paris.
Nuovo cimento	Nuovo cimento, giornale di fisica, chimica, e storia naturale. Pisa and Turin.
Novi comment. acad. sci. imp. petrop.	Academia scientiarum imperialis petropolitana. Novi commentarii. St. Petersburg.
Obs. phys............	Observations sur la physique, sur l'histoire naturelle, et sur les arts. Paris.
Öfvers. k. Svenska. förhandl.	Öfversigt of konigliga Svenska vetenskaps-akademiens förhandlingar. Stockholm.
Oest. landw. Wochenbl.	Oesterreichisches landwirtschaftliches Wochenblatt. Vienna.
Phil. mag............	London, Edinburgh, and Dublin philosophical magazine and journal of science. London.
Phil. trans...........	Philosophical transactions of the Royal Society of London. London.
Phys. rev. (London)..	....
Poligrafo	Poligrafo. Verona.
Proc. Amer. forestry assoc.	Proceedings of the American forestry assoc.
Proc. Ashmol. soc....	Ashmolean society. Abstract of the proceedings. Oxford.
Proc. Asiat. soc. Bengal.	Proceedings of the Asiatic society of Bengal. Calcutta.

Proc. Brit. met. soc..	Proceedings of the British meteorological society. London.
Proc. inst. civ. engin.	Proceedings of the institute of civil engineers. London.
Proc. roy. Irish acad.	Proceedings of the royal Irish academy. Dublin.
Proc. roy. soc. Edinb.	Proceedings of the royal society of Edinburgh. Edinburgh.
Proc. roy. soc. London	Proceedings of the royal society. London.
Quart. jour. roy. met. soc.	Quarterly journal of the royal meteorological society. London.
Quart. jour. sci......	Quarterly journal of science, literature and the arts. London.
Rap. ann. sta. agron. Mauritius.	Colony of Mauritius. Station agronomique. Rapport annuel. Mauritius.
Rpt. Chf. Eng........	U. S. War Department, Annual Report of the Chief of Engineers. Washington.
Rend. r. ist. Lomb...	Reale instituto lombardo di scienze e lettere. Rendiconti. Milan.
Repert. der Phys.....	Repertorium der Physik. (Carl) Munich.
Repert. f. Met.......	Repertorium für Meteorologie. (Wild) St. Petersburg.
Repert. f. Met. Dorpat	Repertorium für Meteorologie. (Kämtz) Dorpat.
Rev. sci.............	Revue scientifique. Paris.
Rev. soc. sav.........	Revue des sociétés savantes. Paris.
Riv. sci. ind	Rivista scientifico industriale. Florence, Italy.
Rpt. Brit. assoc. adv.	Report of the British association for the advancement of science. London.
Samml. Deut. Abh. Akad.	....
Schweiz. met. Beob..	Schweizerische meteorologische Beobachtungen. Zürich.
Sci. Amer.............	Scientific American. New York.
Sci. Amer. sup........	Scientific American, supplement. New York.
Science..............	Science. NewYork.
Sci. mem.............	Scientific memoirs (Taylor.) London.
Sci. pour tous........	La science pour tous. Paris.
Sci. proc. roy. Dublin soc.	Scientific proceedings of the royal Dublin society. Dublin.
Scot. geog. mag......	Scottish geographical magazine. Edinburgh.
Sitzber. k. Akad. Wiss. (Vienna) math. naturw. Kl.	Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse. Vienna.
Sitzber. k. bayer. Akad Wiss. math. phys. Kl.	Sitzungsberichte der königlichen bayerischen Akademie der Wissenschaften, mathematisch-physikalische Klasse. Munich.
Sitzber. k. böhm. Ges. d. Wiss., (Prag).	Sitzungsberichte der kaiserlichen böhmischen Gesellschaft der Wissenschaften. Prague.
Smiths. misc. coll....	Smithsonian Institution. Miscellaneous collections. Washington.
Svenska vetensk. akad Handl.	Königl. svenska vetenskaps Akademi Handlingar. Stockholm.
Symons' met. mag...	Symons' meteorological magazine. London.
Tidskr. math. fys....	Tidskrift för mathematik och fysik. Upsala.
Trans. Amer. phil. soc.	Transactions of the American philosophical society. Philadelphia.
Trans. Amer. soc. civ. engin.	Transactions of the American society of civil engineers. New York.
Trans. Bombay geog. soc.	Transactions of the geographicl society of Bombay. (Bombay.)

Trans. N. Y. State agr. soc.	Society instituted in the State of New York for the promotion of agriculture, arts, and manufactures. Transactions. Albany.
Trans. roy. Irish acad.	Transactions of the royal Irish academy. Dublin.
Trans. roy. Scot. soc. arts.	Transactions of the royal Scottish society of arts. Edinburgh.
Trans. So. African phil. soc.	Transactions of the South African philosophical society. Cape Town.
Utr. Aanteek. prov. genoots.	Provincial utrechtsch genootschap van kunsten, en wetenschappen. Aanteekeningen van het verhandelde in de sectie-vergaderingen. Utrecht.
Van Nostrand's engin. mag.	Van Nostrand's engineering magazine. New York.
Water sup. and irr. papers.	U. S. geological survey. Water supply and irrigation papers. Washington.
Wittenberg Wochenbl.	Wittenbergisches Wochenblatt zum Aufnehmen der Naturkunde und des oekonomischen Gewerbes. Wittenberg.
Woburn exp. fruit farm rpt.	Woburn experimental fruit farm. Reports. London.
Zeits. Arch. Ver......	Zeitschrift des Architecten und Ingenieur Vereins. Hannover, Germany.
Zeits. Deut. geolog. Ges.	Zeitschrift der Deutschen geologischen Gesellschaft. Berlin.
Zeits. Gewässerk.....	Zeitschrift für Gewässerkunde. Leipsic.
Zeits. f. Naturw. Halle.	Zeitschrift für die gesammten Naturwissenschaften. Halle.
Zeits. Oest Ges. Met.	Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie. Vienna.
Zhur. opuitn. agron. (Russ. Jour. exp. Landw.)	Zhurnal opuitnoi agronomii. (Russisches Journal für experimentelle Landwirtschaft.) St. Petersburg.

1670.

Perrault, Claude.

Observations sur l'évaporation de l'eau et sur l'effet du froid sur different huiles. (1670.) Hist. acad. sci., 1666–86, **1**:115–6. (1733.)

Various liquids were exposed to evaporation during cold weather. Water evaporated considerably, oils of bitter almonds, olives, aniseed, walnut, and turpentine evaporated a little, and linseed oil and oil of sweet almonds none at all.

1687.

Halley, Edmund.

An estimate of the quantity of vapor raised out of the sea by the warmth of the sun, derived from an experiment shown before the Royal Society. Phil. trans., 1687, **16**:366–70; also abridged in Phil. trans., abridged, 1683–94, **3**:387–90. (1809.)

A salt solution of the concentration of ordinary sea water (1:40), lost by evaporation at the rate of 0.1 inch in 12 hours. From this it was calculated that the amount evaporated from the Mediterranean in a summer day is at least 5,280 millions of tons. The accelerating influence of wind on evaporation was observed.

1690.

Halley, Edmund.

An account of the circulation of the watery vapors of the sea, and of the cause of the springs. Phil. trans., 1690, **17**:468–73; also abridged in Phil. trans., abridged, 1683–94, **3**:327–30. (1809.)

Advances the theory that evaporation is partly caused by heat expanding water particles into hollow shells lighter than air. Suggests that the air imbibes a certain quantity of aqueous vapor and retains it "like salts dissolved in water."

1692.

Sedileau.

Observations sur la quantité de l'eau de pluie tombée à Paris, durant près de trois années, 1686–90, et de la quantité de l'évaporation. (1692.) Mem. acad. sci., 1666–99, **10**:27–36. (1730); also Hist. acad. sci., 1686–99, **2**:63, 87, 133–5; also Coll. acad. franç., 1754, **1**:257–61.

An experiment carried on from June, 1688, to December, 1690, with evaporation of water showed an average annual amount at Paris of 32.1 inches. The annual rainfall was 19 inches. The rate was found to be higher from small vessels than from larger ones.

1694.

Halley, Edmund.

An account of the evaporation of water, as it was experimented in Gresham College in the year 1693, with some observations thereon. Together with a table showing the quantity evaporated each day, with the heights of the thermometer and barometer. Phil. Trans., **18**:183–90. (1694); also Phil. trans., abridged, 1683–94, **3**:658–9. (1809.)

The low annual evaporation rate of 8 inches, observed from water not exposed to sun and wind, as compared to the annual rainfall of 19 inches at Paris or 40 inches near Lancaster, is believed to show that the sun and wind, especially the wind, are the important factors influencing evaporation.

1709.

Gauteron.

Observations sur l'évaporation qui arrive aux liquides pendant le grand froid, avec des remarques sur quelques effets de la gelée. Mém. acad. sci. 1709, (—):451–71.

An ounce of water allowed to freeze and exposed from 6 p. m. to 8 a. m., lost 24 grains by evaporation. A comparative experiment with various liquids at a low temperature resulted as follows: Ice lost 36 grains; walnut oil, not frozen, 40 grains; brandy and oil of turpentine, not frozen, 54 grains each. Mercury and olive oil were unchanged by the exposure.

1712.

Müller, Johann Heinrich.

Exercitatio. De exhalationibus, tamquam proxima meteorum materia. (Joa. Müller resp.) Altorfiæ. (Altdorf.) 1712. 4to.

1715.

Barlow, E.

Meteorological essays. London. 1715.

"How Vapors, raised by the Sun to several Heights in the Air, grow, by their Descents, condensed into Rain, and Hail, of divers sorts." p. 43–48.

1729.

Desaguliers, Jean Théophile.

An attempt to solve the phenomenon of the rise of vapours, the formation of clouds and the descent of rain. Phil. trans., No. 407, **36**:6. (1729); also Phil. trans., abridged, 1724–34, **7**:323–31.

The the ry expounded by Dr. Niewentyt and others, (see Niewentyt's Religious Philosopher, Contemplation 19, Sections 13–25) that particles of fire separate from sunbeams and combine with particles of water to make molecules specifically lighter than air, wherefore they rise until the air about them is of the same specific gravity as themselves, and that rain is produced by the separation of these particles of fire and water, is objected to on the ground that fire has not been proven to be a distinct element, and that the causes of rain given are contrary to experience. Experimental evidence is presented, favoring the idea that heat gives elasticity to fluids, causing the particles to exert a force of expansion at great distances. Refers to the work of Halley, (1687, 1690, 1694.)

1732.

Musschenbroek, Petro Van.

Ephemerides meteorologicæ, barometricæ, thermometricæ, epidemicæ, magneticæ, ultrajectinæ. Phil. trans., **37**:357–84. (1732.)

Evaporation for the year from a free surface of water was 32 in. 2.75 lines, (Rh.),[2] with a rainfall of 25 in., 1.25 lines, (Rh.).

---

[2] Rhenish measure is indicated by (Rh.) and french measure by (Fr.). The rhenish foot was to the french foot as 139:144.—*G. J. L.*

1734.

Du Fay.

Observations météorologiques faites à Utrecht, pendant l'année 1734, extraites d'une lettre de M. Musschenbroek. Mém. acad. sci., 1734, (—):564–6.

The evaporation for the year 1734 at Utrecht was 25 in., 3 lines (Rh.), and the rainfall was 35 in., 11 7/9 lines (Rh.). The annual average rainfall at Paris is taken as 24 in. (Rh.).

1735.

Du Fay.

Observations météorologiques faites à Utrecht, pendant l'année 1735, extraites d'une lettre de M. Musschenbroek. Mém. acad. sci., 1735, (—):581–4.

Evaporation was 23 inches, 2 lines; the rainfall was 26 inches, 1⅛ lines (Rh.).

1736.

Du Fay.

Observations météorologiques faites à Utrecht, pendant l'année 1736, extraites d'une lettre de M. Musschenbroek. Mém. acad. sci., 1736, (—):503–5.

Evaporation was 28 inches, 11 lines (Fr.), with a rainfall of 22 inches, 9⅔ lines (Fr.).

1741.

Bazin.

Observation sur l'évaporation de l'eau. (Communicated by M. de Réaumur.) Hist. acad. sci., 1741, (—):17–19.

Evaporation was found to be more rapid from moist potter's clay than from a free water surface. It is suggested that this may be due to the difference between the temperatures of the two substances and somewhat to the inequalities of the surface of the soil.

1742.

Bouillet, Jean.

Sur l'évaporation des liquides. Hist. acad. sci., 1742, (—):18–21.

The theory that the circular motion of fluids causes the particles at the surface to pass off tangentially is considered a sufficient explanation for the fact of evaporation. The process is regarded as a solution of these particles in air.

1743.

Stock, J. C.

Dissertatio. De exhalationibus sive effluviis. (Joa. Jac. Algoewer resp.) Jenae. 1743. 4to.

1744.

Kratzensteins, Christian Gottlieb.

Théorie de l'élévation des vapeurs et des exhalaisons, démontrée mathématiquement. Bordeaux. 1745. 4to.

Abhandlung vom Aufsteigen der Dünste und Dämpfe, welche von der Akademie zu Bordeaux den Preis erhalten. Halle. 1744. (Translation of the above.)

According to Saussure (1783), Kratzenstein estimated the vapor vesicles thrown off by evaporation as being of the diameter of a hair.

Richmann, Georg Wilhelm.

Qua ratione instrumentum, quo quantitas aquae, calore atmosphaerae naturali ex superficie aquae certa in aerem elevatae commode mensuratur, construi debeat. Comment. acad. sci. imp. Petrop., 1744–6, **14**:273–5.

Describes an instrument for measuring evaporation, in which the vessel containing the evaporating water is partially sunk in a larger closed vessel also containing water.

1746.

Wallerius, Nils.

Rön, Hvarigenomåtskilliga Naturens lagar, angående Vattnets och andra flytande Materiers utdunstande, frambringas. Svenska vetensk. Akad. Handl. 1746, **7**:1–21, 145–76.

See German translation of 1752.

1747.

Richmann, G. W.

Inquisitio in legem, secundum quam calor fluidi in vase contenti, certo temporis intervallo, in temperie aeris constanter eadem decrescit vel crescit et detectio ejus, simulque thermometrorum perfecte concordantium construendi ratio hinc deducto. Novi comment. acad. sci. imp. Petrop., 1747–8, 1:174–197. Summ., 50–51.

The law deduced from observations is that the variations in the temperature of water, relative to that of the surrounding air, are directly proportional to the surfaces exposed and to the differences between the temperatures of the water and the air, and inversely to the masses. Hence the differences between the temperatures of the air and the water decrease in geometrical progression if the time intervals succeed each other in arithmetical progression.

Richmann, G. W.

Tentamen, legem evaporationis aquæ calidæ in ære frigidiori constantis temperiei definiendi. Novi comment. acad. sci. imp. Petrop., 1747–8, 1:198–205; Summ., 51.

Observations on evaporation of warm water in colder air of a constant temperature, seemed to show that the quantity evaporated is proportional to the successive differences of the differences between the temperature of the water and that of the air.

Richmann, G. W.

Tentamen explicandi phenomenon paradoxon, scilicet thermometro mercuriali ex aqua extracte mercurium in ære, aqua calidiori, descendere et ostendere temperiem minus calidam ac æris ambientis est. Novi comment. acad. sci. imp. Petrop., 1747–8, 1:284–290; Summ., 55.

As a thermometer is drawn from water into air warmer than the water, the temperature indicated continues to fall because the evaporation of the thin layer of water clinging to the bulb of the thermometer cools it.

1751.

Le Roy.

Mémoire sur l'élévation et la suspension de l'eau dans l'air, et sur la rosée. Mém. acad. sci., 1751, (—):481–518.

Observations and experiments are cited to prove the theory that the solution of water in air follows the same laws as solutions of salts in water and other solutions.

Richmann, G. W.

Atmometri sive machinæ hydrostaticæ ad evaporationem aquæ certæ temperiei mensurandam aptæ constructio talis, ut ope ilius decrementum paucorum granorum observari et lex evaporationis confirmari possit. Novi comment. acad. sci. imp. Petrop., [1749–50], 2:121–27; Summ., 9. (1751.)

A closed cylindrical air chamber slides between stationary vertical rods inside of a larger covered vessel containing water. From the upper wall of the air chamber three small rods project vertically thru holes in the cover of the outer vessel and form the support for the metal evaporating vessel. The total weight of the evaporating vessel and contents, the rods and the air chamber, are balanced by the weight of the water displaced by the submerged part of the system. Any loss in weight due to evaporation causes a corresponding rise of the evaporating vessel and can be calculated therefrom.

Richmann, G. W.

Inquisitio in rationem phænomeni, cur aqua profunda in vasis homogenæ materiæ plus evaporet quam aqua minus profunda, et confirmatio experimento nova ratione instituto. Novi comment. acad. sci. imp. Petrop., [1749–50], 2:134–44. (1751.)

Experiments with evaporation from water surfaces at different depths in vessels of similar material showed that less evaporation takes place from the shallower water. The cause of this seems to lie in the observation that if the ratio of the whole surface of the larger mass to the whole surface of the smaller is less than the ratio of the greater mass to the lesser mass, then the latter assumes the temperature of the air more quickly than does the former, and vice versa. This is not believed to be applicable to large natural bodies of water, since many complicating differences arise.

Richmann, G. W.

De evaporatione ex aqua frigidori aere observationes et consectaria. Novi comment. acad. sci. imp. Petrop., [1749–50], 2:145–61; Summ., 11–13. (1751.)

Experiments with evaporation from water colder than the air above it showed the following relations: Condensation, and not evaporation, occurs when the temperature of the air is between 60° and 70° F. if the temperature of the water is more than 15° below it, and also when the temperature of the air is between 75° and 87° if the water is 20° colder. A discussion of the application of these facts to general meteorology follows.

1752.

Wallerius, Nils.

Versuche, wodurch verschiedene Gesetze der Natur die Ausdünstung des Wassers und anderer flüssigen Materien betreffend, entdeckt werden. Svenska vetensk. akad. Handl., 1746, 7:1–21, 145–176, Uebersetzt von A. G. Kästner. Hamburg. 1752.

Describes experiments with a weighing evaporometer extending thru 5 years, from which the following laws are deduced: Evaporation is proportional to the surface in contact with the air; increased temperature increases evaporation; increased movement of the air increases evaporation. The addition of salt (NaCl) and saltpeter (KNO_3) to water hindered evaporation at first but not finally. This initial decrease is believed to be due to the cold produced upon the addition of the salt. Sugar and vitriol were used as solutes without the retarding effect. Milk evaporated as rapidly as water until the cream was formed, when the rate decreased. Alcohol, wine and olive oil were also experimented with.

1753.

Baron.

Expériences sur l'évaporation de la glace. Mém. math. phys. acad. sci., 1753, (—):250–68.

Discusses the fact shown by Sedileau and Mariotte, and later confirmed by Gauteron and Mairan, that ice evaporates. In January, 1753, Baron's experiments showed that ice always evaporates more or less, but not proportionally to the coldness of the air. He considers that the phenomenon is due to the blowing off of fine particles of water by the wind, and that it is "not true evaporation."

1756.

Franklin, Benjamin.

Physical and meteorological observations, conjectures, and suppositions. Read June 3, 1756. Phil. trans., 55:182–92.

Considers evaporation a chemical solution of water in air.

1757.

Franklin, B[enjamin].

Letter to John Lining, 1757. Published in his Complete Works, edited by John Bigelow, 1887; 2:498, and 3:22. Also translated in Obs. Phys., 1773, 2:453–7.

An experiment was repeated which had been described by Professor Simson of Glasgow, which consisted in keeping wet the bulb of a thermometer with alcohol and thereby producing a temperature several degrees lower than it would otherwise have. The cooling effect of evaporation is further discussed in 3:22.

1763.

Desaguliers, Jean Théophile.

A course of experimental philosophy. London. 1763. Lecture 10, Hydrostatiks, 2:249–374.

Discusses at length the nature of evaporation, refuting the idea that particles of fire unite with particles of water to lift them into the air; and the other idea that water in sunshine forms spheres with an "aura or finer air" inside which buoys them upward. Proposes the idea that heat increases the repellant force between the particles, a solid thus becoming a liquid and a liquid a gas.

1764.

Haller, Albrecht v.

Sur l'évaporation de l'eau salée. Mém. acad. sci., 1764, (—):9–74. Also abstracted in Hist. acad. sci., 1764, (—):25–31.

A salt solution was found to evaporate less rapidly as it became more concentrated. Gives tables of evaporation from salt water in large shallow basins from March to October in the years 1759–64, with the state of the sky, the average daily temperature, and the product in salt at the end of each experiment. From these observations the annual evaporation at the salt works of Bevaix in Switzerland is valued at 22 in., 1.25 lines.

1765.

Hamilton, Hugh.

A dissertation on the nature of evaporation and several phenomena of air, water, and boiling liquors. Phil. trans., 1765, 55:146–81. Also translated in Neu Hamburg Mag., 1767, 2:147–92.

Refutes all earlier theories which assign "rarefaction by heat" as the chief if not the only cause of evaporation. Considers the process to be nothing more than a gradual solution of water in air, produced and promoted by the same means—attraction, heat and motion—by which other solutions are affected. Gives experiments, observations, and discussion.

1766.

Hamilton, Hugh.

On the ascent of vapors, the formation of clouds, rain, and dew, and on several other phenomena of air and water. In his Philosophical Essays: London, 1766, 8vo; 2d ed., 1767, 12mo; 3d ed., 1772, 12mo; 4th ed., 1783, 12mo. Also in his Works: London, 1809, 2 vols. 8vo.

Same as article of 1765.

1770.

Lavoisier.

De la combinaison de la matière du feu avec les fluides évaporables, et de la formation des fluides élastiques aeriformes. Mém. acad. sci., 1770, (—):420–32.

The cooling produced by evaporation is advanced as proof of his theory that there is an absorption of "matière du feu" or "igneous fluid" in the formation of vapors, or that vapors are a result of the combination of the "matière du feu" with the fluid.

1771.

Kames, H. H.

On evaporation. Essays obs. phys. lit., 1771, **3**:99. Also translated in Obs. phys., 1773, **2**:97–104.

Further support is given to the theory that evaporation is a solution of water in air.

1773.

Gabler, P. M.

Theoria vaporum. Ingolstad. 1773. 4to.

1774.

Cotte, P.

Traité de Météorologie. Paris. 1774. xxxvi + 635. 4to.

Reviews various theories of evaporation, p. 39 et seq. Discusses (p. 61) evaporation from ice, quoting Gauteron (1709). Sedileau (1692), is quoted, p. 317. Cotte gives 28 inches as the amount of annual evaporation at Montmorenci, from two years' observations. The size, nature, and exposure of the vessels employed are considered to have a marked influence on the rate of evaporation. He believes Musschenbroek showed that evaporation does not take place equally from two vessels of the same length and breadth but of different depths; it is more rapid from the deeper vessel. M. found that the cubes of the quantities evaporated from two vessels are to each other as the heights of the fluids in the vessels. (Additions de M. Musschenbroek aux expériences de l'Acad. del cimento in Collection académique, vol. 1 (part. étrang.): 142, n. d. Cotte also refers (p. 307) to a large number of experiments on evaporation of water and ice conducted by J. Broval (Mém. de l'Acad. de Stockholm), Hales (Vegetable Statics. London, 1726), Desaguliers (Cours de phys. expér., vol. 2, p. 345, translation of P. Pezenas), Musschenbroek (Cours de Phys., vol. 2, p. 301, translation of M. Sigaud de Labond).

1775.

Barker, Robert.

The process of making ice in the East Indies. Phil. trans., 1775, **65** (pt.2):252–7. Also Phil. trans., abridged, 1770–76, **13**:644–5.

The cooling produced by evaporation is taken advantage of in the East Indies where ice is made by leaving water in porous clay pans over night.

1777.

Dobson, Matthew.

Observations on the annual evaporation at Liverpool, in Lancashire; and on evaporation considered as a test of the moisture or dryness of the atmosphere. Phil. trans., 1777, **67**:244–59. Also Phil. trans., abridged, 1776–80, **14**;137–43. Also abstracted in Obs. phys., 1779, **13**:81–5.

The rate of evaporation is considered to be a more accurate test of the moisture or dryness of the air than the quantity of rainfall. A table shows the mean monthly evaporation, rainfall, temperature, and velocity of the wind, and also a comparison of the evaporation rate for the different seasons of the years 1772–5. The annual evaporation at Liverpool, from four years' observations, is given at 36.78 in., with a rainfall of 37.43 in. Halley's experiments are referred to, (1687, 1690, 1694), also those of Cruquius, who observed an annual evaporation at Delft, of 30 inches from water set in the open air but not in the sun and wind. Experiments showing that evaporation did not take place from water placed in a vacuum seemed to prove that air is a chemical solvent of water and as such is an important cause of evaporation. Heat, when of a sufficient degree being another cause, may produce this effect without the intervention of air, the evaporation proceeding rapidly in an exhausted receiver as in the experiments of Dr. Irving in Phipp's Voyage to the North Pole, p. 211.

Hunter, Alex.
Georgical Essays. York, England. 1777. Essay VIII, On air dissolving water, p. 95–130.

Discusses the general facts and theory of evaporation. The author takes the position that evaporation is merely a form of solution, the water dissolving in the air.

1779.

Fontana, l'Abbé.
Mémoire sur l'évaporation des fluides dans l'air non renouvellé. Obs. phys., 1779, **13**;22–38.

Experiments seem to show that the more volatile fluids such as ether, which evaporate so easily in the free air, do not evaporate at all when enclosed in air-tight vessels, and that even the action of heat upon these fluids does not increase the rate, proving that there is no sensible evaporation of liquids, although naturally volatile, if the air is not renewed.

1780.

Achard.
Dissertation sur la cause d'élévation des vapeurs. Obs. phys., **15**:463–77. (1780.)

Supports the solution theory of evaporation.

Achard.
Mémoire sur le froid produit par l'évaporation. Obs. phys., **16**:174–86. (1780.)

Quotes letter to Dr. Lining from B. Franklin (1757). Gives tables of results obtained from observations on the lowering of the temperature of many different liquids when subjected to evaporation.

Schotte, J. P.
Journal of the weather at Senegambia during the prevalence of a very fatal putrid disorder, with remarks on that country. Phil. trans., 1780, **70** (pt. 2):478–506.

The author refers (p. 486) to the enormous rate of evaporation at St. Louis, or Sénégal, 16° N. lat., 16° W. long., where the natives cool water in tanned leather bags hung in the open air. Also quoted by Watson, 1781.

1781.

Cotte, Louis.
Expériences sur les quantités d'évaporations relatives à la hauteur et au diamètre des vases qui servent à les mesurer. Obs. phys., 1781, **18**:306–9; translated in Mag. neu. Phys. und Naturgesch., **1** (pt. 3):36–42. (1785.)

Experiments to determine the influence of the dimensions of the containing vessel on the rate of evaporation (cf. Cotte, 1774) show that evaporation has no relation to the height of the vessel. that it is not proportional to the volumes nor to the exposed amount of the interior surface of the walls, but that there is as much variety in the results as there is in the form of the vessels used.

Watson, Richard.
Chemical Essays. London. 1781. 5 vol. 12mo. 7th ed., 1800.

In volume 3, essay 2 (p. 51–74), the evaporation from an acre of "dry ground" is estimated to be over 1,600 gallons in 12 hours of a hot summer day, and more if the ground is moist In essay 3 (p. 75–117) the process of evaporation is likened to the solution of salts in water. Essay 4 (p. 119–142) contains a discussion of the cooling produced by evaporation, as shown by experiments with the wet bulb thermometer, and by the methods employed in hot countries of cooling wine, water, etc., by wrapping wet cloths about the flasks, or by keeping them in porous jars or leather bags. He cites Professor Braun's table of the degrees of cold produced by the evaporation of different fluids (Novi comment. acad. sci. imp. Petrop., 1764, **10**).

1782.

Eason, Alexander.
On the ascent of vapor. (1782.) Mem. lit. phil. soc., 1785, **1**:395–405.

Schwaiger, Herculanus.
Beschreibung eines Verdünstungsmessers. Bayer. met. ephem., 1782, **2**.

1783.

Paterson, J.
De evaporatione complectens. Edinburgh. 1783. 8vo.

Saussure, Horace Bénédicte de.
Essais sur l'Hygrométrie. Neuchâtel. 1783. xxiv+367. 2 pls. 4to.

Essay 3 deals with the theory of evaporation in which it is concluded that: (1) evaporation is the effect of the intimate union of elementary heat with water whereby is formed an elastic fluid, called vapor, rarer than air; (2) this vapor is called pure elastic vapor when formed in a void, or when its abundance and sustained heat give it force to repel the air which presses it; (3) but when this same vapor cannot entirely surmount the compressive force of the air, it penetrates and mingles with it and undergoes a true dissolution, and is then called dissolved elastic vapor; (4) when the saturated air is allowed to precipitate the vapor which it contains, this water sometimes takes the form of vesicles or little bubbles; these vesicles, filled with and enveloped by a rare, light fluid, float and rise because they are specifically lighter than air, and constitute vesicular vapor; (5) when the elastic vapor, or the vesicles themselves, are condensed in full drops, differing from rain drops only by their extreme smallness, they are still very different from vapor, properly speaking; but as they float in the air and can even be sustained for some time by its movement and by its viscosity, they are classed with vapors and called concrete vapor.

The essay closes with a discussion of the theories and experiments of Kratzenstein, Priestley, Nollet, Cullen, Lambert, Richmann, Musschenbroek, Wallerius, Kraft, Gautheron, Haller.

Schwaiger, Herculanus.
Descriptio atmidometri nostri et methodi quam in observando adhibemus. Mannheim ephem. soc. met. palat., 1783, **4**:300.

Titius, J. D.
Ueber die Ausdünstung des Eises. Wittenberg. Wochenbl., 1783, **16**:309–10.

Discusses the results of Braun and Saussure concerning evaporation of ice, and concludes that evaporation follows the same general law in the case of ice as in that of water, except at the moment of freezing, when the evaporation appears to be greater than it should be.

1784.

Saussure, H. B. de.
Versuch über die Hygrometrie. Uebersetzt aus dem französischen von Johann Daniell Titius. Leipsic. 1784. 8vo.

Translation of his Essais sur l'Hygrometrie of 1783 (q. v.).

1786.

Rosenthal, Gottfried Erich.
Ueber P. Cotte's Versuch die Stärke der Ausdünstungs im Rücksicht auf die Höhe und den Durchmesser der Gefässe die zum Maasse gebraucht werden. Mag. neu. Phys., 1786, **1** (pt. 4):142–54.

It is claimed that the law of differences, for evaporation from different vessels, which Cotte (1781) failed to find, is as follows: (1) dishes of like height and surface give like evaporation in the same time and place; (2) dishes of like height and unlike evaporating surfaces give the same evaporation if reckoned by depth, but different if by volume; (3) in the case of dishes of different heights, with like or unlike evaporating surfaces, the depth of water lost by evaporation is proportional to the square roots of their heights.

Williams, Samuel.
Experiments on evaporation, and meteorological observations made at Bradford, in New England, in 1772. Trans. Amer. phil. soc., 1786, **2**:118–41.

In experiments with evaporation from two small vessels, the amount lost from the one refilled every week was found to be greater than that from the dish which was refilled only once a month. A vessel floated in the Merrimac River during a calm, rainless week lost 0.15 in. by evaporation, while a similar vessel freely exposed in the open air lost 1.50 in. Evaporation was found to be greater from soil covered with vegetation than from equal areas of free water surface.

1788.

Cotte, P.
Mémoires sur la météorologie. Paris. 1788. 2 v. 4to.

Discounts (**1**:100) the influence of moonlight on evaporation. Reviews (**1**:175–265) experimental and theoretical investigations of various physicists, including Wallerius, Lambert, Musschenbroek, Van Swinden, Richmann, Kratzenstein, Hamberger, Homberg, Desaguliers, Franklin, Kames, Dobson, Achard, etc. Describes experiments as in 1781, to ascertain the influence of the diameter and height of the containing vessels upon the rate of evaporation. Describes (**1**:280) a simple evaporator used by Chevalier de la Mark. Discusses (**1**:480) the cooling effect of evaporation as demonstrated with the moistened bulb of a thermometer.

1789.

Saussure, H. B. de.

Col du Géant; expériences sur l'évaporation. Obs. phys., 1789, **34**:161–80. Translated in Jour. Phys., Leipsic, 1790, **1**:453–73. Reprinted in Voyages dans les Alpes. Geneva, 1779–96. 4 vols., 4to.

Evaporation from a moist piece of linen stretched in a frame, was observed on the Col du Géant, where the air pressure is only 18 in. 9 lines, and at Geneva, Switzerland, where it is 27 in. 3 lines, with the result that "other things being equal, a lowering of the pressure of the air by approximately a third makes the quantity of evaporation more than twice as great." Deals also with the cooling effect produced by evaporation.

1790.

Deluc, John Andrew.

Seconde lettre à M. Delamétherie sur la chaleur, la liquefaction, et l'évaporation. Obs. phys., 1790, **36**:193–207. Translated in Jour. Phys., Leipsic, 1790, **2**:402–29.

Discusses theories to explain the process of evaporation. That of the solution of water by air is considered "a vague hypothesis without solid foundation and useless to explain the phenomenon." He maintains that evaporation proceeds from the union of fire with the molecules of the liquid.

Hube, J. M.

Ueber die Ausdünstung und ihre Wirkungen in der Atmosphäre. Leipsic. 1790. 2 vols. in 1. 8vo.

Monge, Gaspard.

Sur la cause des principaux phénomènes de la météorologie. Ann. chim. phys., 1790, **5**:1–71.

The vesicular hypothesis of evaporation is rejected in favor of the theory of the solution of water vapor in the air, on the following grounds: (1) Air in absorbing water preserves its transparence, which could not happen if the water was merely suspended by some mechanical means; (2) the solvent power of air diminishes as the quantity of water dissolved increases, so that an actual saturation is reached; (3) the point of saturation varies with the temperature of the air, so that air saturated at a high temperature contains more water than air saturated at a lower temperature; (4) if air saturated with water is cooled it becomes supersaturated and abandons the water which its former higher temperature permitted it to retain. It is concluded that, since these circumstances ordinarily accompany all solutions and are generally regarded as characteristic of them, the absorption of water by air is the result of a true solution.

1791.

Deluc, J[ohn] A[ndrew].

Examen d'un mémoire de M. Monge, sur la cause des principaux phénomènes de la météorologie. Ann. chim. et phys., 1791, **8**:73–102. Translated in Jour. Phys. Leipsic, 1792, **6**:121–48.

It is maintained that Le Roy's experiments at Montpelier, which Monge (1790) accepted as decisive proof that evaporation is the solution of water in air, are better explained by considering fire as the sole agent.

Vassali-Eandi, A. M.

Esame delle teorie dei principali fenomeni della meteorologica del Sign. Monge, colle riflessione del Sign. ———. Biblioteca oltremontana. Turin. 1791.

1792.

Deluc, John Andrew.

On evaporation. Phil. trans., 1792, **82**:400–28. Also in Phil. trans., abridged, 1791–96, **17**:259–63. Translated in Jour. Phys. Leipsic, 1794, **8**:141–60, 293–302.

The fact that every liquid cools when it evaporates is considered a most decisive reason for the opinion that the dissolution of water, observed in the phenomenon of evaporation, results directly from the action of heat without the intervention of air. Hygrology is defined as the science of the causes of evaporation and the modifications of evaporated water. A discussion of hygrometry follows with the conclusion that the product of evaporation is always an expansible fluid which affects the manometer by pressure and the hygrometer by moisture, without any hitherto perceived influence from the presence or absence of air.

1793.

Dalton, John.

Meteorological observations and essays. London, 1793. p. xvi+208. 8vo.

The process and circumstances promoting evaporation are described in Pt. 2, Essay 6, p. 132 *et seq*. Heat, dry air, and decreased pressure of the atmosphere upon the evaporating surface are emphasized. In the author's experiments, the rate of evaporation from water, "pretty much exposed to sun and wind," never exceeded 0.2 in. daily. In March the daily average was 0.033 in. It is considered probable that "the evaporation both from land and water, in the temperate and frigid zones, is not equal to the rain that alls, even in summer."

Wistar, Caspar.

Experiments and observations on evaporation in cold air. Trans. Amer. phil. soc., 1793, **3**:125–33.

The author believes these experiments and observations support Deluc's theory, which ascribes the "smoking" of water to the passage of "heat" or "fire" from the moist body into the air around it, a process which does not depend "upon a positive degree of heat, but merely an excess of it in the moist body when compared with the air to which it is exposed."

1794.

Senff, Erdmann Friedrich.

Beobachtungen und Versuche über den Erfolg verschiedener Abdünstungs-Arten des süsses Wassers aus Salz-Soolen auf Salzwerken nebst Folgerungen daraus. (1775, May–Oct.) Jour. Phys. Leipsic, 1794, **8**:84–94, 357–66.

Evaporation from water freely exposed from May to October, inclusive, in a small tin vessel amounted to 24 inches, 13/24 line; the rainfall for the same time being 9 inches, 2½ lines. Experiments made with aqueous salt solutions of different strengths showed that the strongest solutions lost least by evaporation. From a table giving the results of similar experiments under different temperatures, it may be calculated that the ratios between evaporation rates from different solutions approach each other as the temperature increases.

Zylius, J. D. O.

Ueber Herrn Deluc's Lehre von der Verdünstung und dem Regen. Jour. Phys., Leipsic, 1794, **8**:51–64.

After discussing the nature of evaporation the author concludes that it is an actual solution of water in air.

1799.

Wistar, Caspar.

Experiments on evaporation. Trans. Amer. phil. soc., 1799, **4**:72-3, Also in Med. repos., 1801, **4**:179–80.

His conclusions are similar to those in his paper of 1793.

1800.

Heller, Egidius.

Ueber den Einfluss des Sonnenlichts auf die Verdünstung des Wassers. Ann. Phys., 1800, **4**:210–22.

Describes observations which tend to show that, the temperature of the air remaining constant, evaporation varies with the amount and strength of sunlight falling on the evaporating surface.

1801.

Dalton, John.

New theory of the constitution of mixed aeriform fluids, and particularly of the atmosphere. Jour. nat. phil. chem., 1801, **5**:241–4.

Proposes "four suppositions in respect to the affections of the particles of one elastic fluid toward those of another," and adopts the idea that "particles of one elastic fluid may possess no repulsive (or attractive) power, or be perfectly inelastic with regard to the particles of another; and consequently, the mutual action of such fluids, or the action of the particles of one fluid on those of another, will be subject to the laws of inelastic bodies." Two mixed fluids, "whatever their specific gravity may be, will immediately, or in a short time, be intimately diffused thru each other, in such a manner that the density of each considered abstractedly, will be uniform thruout." The particles "will diffuse themselves thru any given space, occupied by a very rare medium, in the same manner as they would do in a vacuum, each particle being impelled as far as possible from its neighboring particle; only the diffusion of each may be a little retarded by the other." "The vapor of water and of every other fluid which does not unite chemically with the azotic and oxygenous gases of the atmosphere, and without any regard to its pressure on the surface of the earth, being totally uninfluenced by any other pressure than that arising from the weight of their own particles: in short, each vapor, in regard to pressure, is in the same circumstance as if it were the only elastic fluid constituting the atmosphere." "Those gases and vapors press separately on the surface of the earth; and any one of them may be withdrawn or another added to the number, without materially disturbing the rest, or in any way affecting their density. The above doctrine necessarily requires the force of vapor from any fluid to depend solely upon temperature, and consequently to be the same in any gas as in an exhausted receiver."

Hermstaedt, S. F.
Versuche über den Einfluss der Elektricität auf die Verdünstung und meteorologische Folgerungen daraus. Ann. Phys., 1801, **7**:501–11.

A mass of air, of known volume at the freezing point, was enclosed over a water seal and heated to 100° (F. ?). The air expanded a certain amount and, upon being recooled to freezing, resumed its original volume. The same air was then subjected to the action of electricity from an electrical machine, cooled, heated, and recooled, as before, when the air appeared to have been permanently expanded. The author concludes that this permanent expansion resulted from the permanent elasticity given to some of the water vapor by the electricity.

Mons, J. B. v.
Censura commentarii a Wieglebo nuper editi, cui titulus: de vaporis aquei in aerem conversione. Brussels. 1801. 4to. Also, Chem. Ann., 1801, **1**:76–84, 129–43, 185–200.

Parrott, G. F.
Grundzüge zu einer neuen Theorie der Ausdünstung und des Niederschlags des Wassers in der Atmosphäre. Mag. f. neu Zustand Naturk., 1801, **3**:1–57.

An extensive series of experiments, with deductions from his own and others' work, results in an elaborate theory of the phenomenon of evaporation, and of cloud and rain formation. The theory is based on several erroneous conceptions, *e. g.*, that evaporation from ice is oxidation.

Parrott, G. F.
Vermischte physikalische Bemerkungen. Ann. Phys., 1801, **10**:166–218.

A distinction is assumed between physieal and chemical evaporation; the former is supposed to be dependent on the temperature and the latter on the oxygen content of the air.

1802.

Böckmann, Carl Wilhelm.
Einige Vorläufige Bemerkungen über Herrn Prof. Parrott's neue Theorie der Verdünstung und des Niederschlags des Wassers in der Atmosphäre. Ann. Phys. Leipsic, 1802, **11**:66–88.

The author doubts the validity of the experimental evidence furnished by Parrott (1801) and the theoretical conclusions of his paper are controverted.

Dalton, John.
Experimental essays on the constitution of mixed gases; on the force of steam or vapor from water and other liquids in different temperatures, both in a Torricellian vacuum and in air; on evaporation and on the expansion of gases by heat. Mem. lit. phil. soc., 1802, **5**:535–602. Translated in Bull. soc. philom., 1803, **3**:189–91; also in Ann. Phys., 1803, **12**:310–18.

The theory of the chemical solution of water vapor in air is declared to be complex and attended with difficulties, such as that it can exist independently in a vacuum at any temperature. Adopts a theory which admits of a distinct elastic vapor in the atmosphere at all temperatures and uncombined with either of the principal constituent gases. Some general laws of evaporation established by others are exprest.

The objects of the essay are: (1) to determine the effect of temperature on the rate of evaporation; (2) to determine the relative evaporability of different fluids; (3) to find a rule for ascertaining the quantity and effect of water vapor previously in the air; (4) from these and other facts to obtain a true theory of evaporation. A table shows the force of vapor and the full evaporating power of every degree of temperature from 20° to 85° exprest in grains of water raised per minute from a vessel 6 inches in diameter, supposing there were no vapor already in the atmosphere. He determined, by weighing, the amount of water evaporated from two tin dishes, one 6 inches in diameter and ½ inch deep, the other 8 inches in diameter and ¾ inch deep; and found that, for high temperatures, the rate of evaporation was exactly proportional to the vapor tension. To test this principle for low temperatures it was found necessary to consider the partial pressure of the water vapor actually existing in the atmosphere. It is concluded that the evaporating force is equal to the vapor tension at the temperature of the water, diminished by that at the temperature of the air. The same principle was found to hold below the freezing point. He refers to Saussure's experimental determinations of the amount of elasticity imparted to dry air by imbibition of aqueous vapor, and shows that the results coincide rather closely with his own. Dalton, however, considers that Saussure placed too much confidence in his [hair?] hygrometer, and that his observations seem to corroborate the theory that aqueous vapor is a distinct elastic fluid rather than a chemical solution of water in air as he supposed.

Dalton, John.

Experiments and observations made to determine whether the quantity of rain and dew is equal to the quantity of water carried off by rivers, and raised by evaporation; with an inquiry into the origin of springs. Mem. lit. phil. soc., 1802, 5:346–72. Translated in Ann. Phys., 1803, 15:249–78.

The annual rainfall over England and Wales is estimated at 31 inches, and dew-fall at 5 inches, while the runoff of the rivers accounts for only 13 inches, leaving 23 inches to be accounted for by evaporation. An experiment was made with a cylindrical tinned iron vessel, 10 inches in diameter and 3 feet deep, with two tubes inserted in one side and turned downward (for collecting surplus water in bottles), one tube near the bottom, the other an inch from the top. This cylinder was filled with gravel and sand to the depth of a few inches, then with fresh soil, and the whole was sunk in the ground, the side bearing the tubes being exposed. The layer of soil was kept saturated with water. Three years' observations (1796–8) in which the annual average rainfall was found to be 33.55 inches, showed the evaporation from soil to be 25.14 inches, and that from a free water surface, 44.43 inches. Hence, he concluded that: (1) under the above circumstances, 25 inches of the rainfall and the 5 inches estimated for dew, making a total of 30 inches, are evaporated annually; (2) the quantity of evaporation increases with the rainfall, but not proportionally; (3) there is, apparently, no great difference between the amount of evaporation from bare earth with sufficient depth of soil, and that from ground covered with vegetation. The difference between the amount calculated as available for evaporation and the observed amount, is taken to support the theory that the earth derives a supply of water from some subterranean reservoir. Reasons, however, are given for considering the observed evaporation as perhaps greater than the actual, and it is finally concluded that "the rain and dew of this country are equivalent to the quantity of water carried off by evaporation and the rivers."

Dalton, John.

New theory of the constitution of mixed gases elucidated. Phil. mag., 1802, 14:169–73. Also Jour. nat. phil. chem., 1802, 3 (n. s.):267–71. Translated in Ann. Phys., 1803, 12:438–45.

A further explanation of the same theories announced in 1801.

Kirwan, Richard.

Of the variations of the atmosphere. Trans. roy. Irish acad., 1802, 8:278–330.

In the chapter on evaporation, the causes of evaporation are said to be "heat, affinity to atmospheric air, agitation, electricity, and light." Discusses Saussure's experiments with a card supersaturated with moisture, which lost 2 grains in a quarter of an hour when electrified, while another, not electrified, lost $1\frac{1}{2}$ grains. Reprints Saussure's table (1789) comparing evaporation at different altitudes.

1803.

Cotte, L.

Observations météorologiques faites à Montmorenci près Paris pendant l'année 5 (1797) de la République. Mém. inst. nat. sci. et arts, 1803, 4:261–5.

The amount of evaporation for the year 1797 is reported as 18 inches, with a rainfall of 26 inches, 6.8 lines. (Fr. ?.)

Dalton, John.

Eine neue Theorie über die Beschaffenheit gemischter luftförmiger Flüssigkeiten, besonders der atmosphärischen Luft [aus Jour. nat. phil. chem. 5:241]. Ann. Phys., 1803, 15:385–95.

Translation of Dalton, 1801.

Dalton, John.

Versuche über die Expansivkraft der Dämpfe von Wasser und andern Flüssigkeiten, sowohl in luftleeren Räumen als in der Luft [aus Mem. lit. phil. soc., 5:550, et seq.]. Ann. Phys., 1803, 15:1–24.

Dalton, John.

Versuche über die Verdünstung [aus Mem. lit. phil. soc., 5:574, et seq.]. Ann. Phys., 1803, 15:121–43.

Dalton, John.

Sur l'expansibilité des gaz mélangés avec les vapeurs, extraite et traduit du Repertory of Arts par Houry. Jour. mines, 1803, 14:33–6.

Gilbert, Ludwig Wilhelm.
Einige Bemerkungen zu Dalton's Untersuchungen über Verdünstung. Ann. Phys., 1803, **15**:144–68.

Discusses the theories of evaporation held by Dalton, Saussure, Deluc, etc.

Hermstaedt, S. F.
Observations sur une méthode d'évaporation spontanée de l'eau des puits salins à la température de l'atmosphère; considérations sur le degré d'utilité des applications qu'on pourrait faire dans les salines du Royaume, et recherches sur les causes physiques qui concourrent pour produire cette évaporation. Mém. acad. sci., 1803, (—):91–104. Also Samml. Deut. Abh. Akad., **6**:63–73. Also Neu. allg. Jour. Chem., 1804, **2**:317–34.

Parrott, G. F.
Ueber Herrn Wrede's Bemerkungen gegen seine hygrologische Theorie. Ann. Phys., 1803, **13**:244–50.

Answer to Wrede's criticisms in connection with the theories announced in the papers of 1801. (See Wrede, 1803.)

Parrott, G. F.
Ueber den Phosphor, das Phosphor-Oxygenometer, und einige hygrologische Versuche, in Beziehung auf Herrn Prof. Böckmann's vorläufige Bemerkungen über diese Gegenstände. Ann. Phys., 1803, **13**:174–207.

Answer to Böckmann's criticisms of his theories. (See Böckmann, 1802.)

Wrede, E. F. K.
Kritische Bemerkungen über einige neuere Hypothesen in der Hygrologie, besonders über Parrott's Theorie der Ausdünstung und Niederschlagung des Wassers in der atmosphärischen Luft. Ann. Phys., 1803, **12**:319–52.

Discussion and criticism of Parrott's (1801) theory of chemical and physical evaporation, Hube's (1790) vesicular system, etc.

1804.

Soldner, Johann von.
Ueber das allgemeine Gesetz für Expansivkraft des Wasserdampfes durch Wärme, nach Dalton's Versuchen; nebst einer Anwendung dieses Gesetzes auf das Verdünsten der Flüssigkeiten. Ann. Phys., 1804, **17**:44–81.

A mathematical discussion of the law of increase of vapor tension for every degree of rise in temperature, and the application of this law to the evaporation of liquids. Discusses Dalton's law and develops a formula by which, from the elastic force and the observed evaporation of any liquid at its boiling point, the evaporation at any other temperature may be determined.

1805.

Blanchet, F.
On the vapor which rises from the surface of the River St. Lawrence during the severe cold of winter. Med. repos., 1805, **3**:154–5.

Mayer, Johann Tobias.
Lehrbuch über die physische Astronomie, Theorie der Erde und Meteorologie. Göttingen. 1805.

Discusses, p. 168–81, the influence of different temperatures of both the evaporating surface and the surrounding air, on the rate of evaporation; also the influence of sunlight and of different surfaces and depths of the evaporating mass. Defines the atmometer as a glass vessel filled with water, the evaporation from which is measured by a graduated scale or by weighing. For the best results it should be floated on the surface of some large body of water. Discusses the seasonal variations in the amount evaporated.

1807.

Flauguerges, Honoré.
Mémoire sur le rapport de l'évaporation spontanée de l'eau avec la chaleur. Jour. phys., Paris, 1807, **70**:446–53. Translated in Jour. nat. phil. chem., 1810, **27**:17–24.

Experiments to determine whether evaporation is proportional to the extent of surface exposed, or is dependent on some function of the other dimensions of the body of water, as Musschenbroek and Cotte asserted, proved that it is simply proportional to the surface exposed. Experiments to determine the effect of heat seemed to show that, while the degrees of temperature vary in arithmetical progression, the corresponding losses by evaporation vary in geometrical progression. The following formula shows the relation:

$$y=(4.4)\,.\,(2.7182818)^{\frac{x}{11.0527301}},$$

in which x represents the degree of temperature on Deluc's thermometer and y the corresponding evaporation, exprest in parts of the scale used. For the evaporation in millimeters y must be multiplied by $\frac{27.07}{196}$, or we may substitute 0.6268843 for the coefficient 4.4 in the equation.

Soldner, Johann v.

Nachtrag zu der Abhandlung über das allgemeine Gesetz der Expansivkraft der Wasserdämpfe. Ann. Phys., 1807, **25**:411–39.

This is a continuation of his paper of 1804, and a discussion of Dalton's law of vapor tension.

1809.

Cotte, Louis.

Mémoire sur l'évaporation. Jour. phys., Paris, 1809, **68**:434–41.

1810.

Cotte, Louis.

Mémoire sur l'évaporation. Jour. phys., Paris, 1810, **70**:206–8.

D'Aubuisson de Voisan, J. F.

Notice sur la quantité d'eau en vapeur contenue dans l'atmosphère, sur la diminution de densité qui en resulte, et sur le produit de l'évaporation en un temps déterminé. Jour. mines, 1810, **27**:411–9.

In discussing the laws of vapor tension and density he derives a formula for the diminution of the density of air due to water vapor. The annual average weight of the vapor contained in a cubic meter of air is given as 9.0 grams, and the annual average diminution of density is 0.0029, the density of air being 1.0. A formula is derived for the quantity of water, Q, evaporated at temperatures between 60° and 100°: $Q=n\phi'$, where ϕ' is the elastic force of vapor at the temperature, and n is a constant to be determined by experiment. Tables show the monthly evaporation calculated for Geneva, that observed at the Observatoire de Paris in 1809, and the evaporation at different elevations as observed by Humboldt, Gay-Lussac, and Saussure.

Fischer, Ernst Gottfried.

Darstellung und Kritik der Verdünstungslehre nach den neuesten besonders den Daltonschen Versuchen. Berlin. 1810. 8vo.

Flauguerges, Honoré.

Mémoire sur le rapport de l'évaporation de l'eau avec l'humidité de l'air. Jour. phys., Paris, 1810, **70**:157–67. Translated in Jour. nat. phil. chem., 1812, **32**:330–9.

In an experiment to ascertain the influence of humidity on evaporation, air was dried by exposure to lime for three weeks. A vessel was then filled with this air by displacement of sand and it was found that, at a constant temperature, the rate of evaporation from a water surface exposed therein decreased in geometrical progression with the increase in humidity. The author concludes that the rate of evaporation is proportional to the amount of additional water vapor needed for saturation; and points out that this agreement with the law of solution of solids in liquids appears to confirm the hypothesis of Musschenbroek and Le Roy that evaporation of water is merely a solution of this substance in air. Following Saussure, the author determined the absolute humidity of saturated air at 65° F. and announced formulas for finding the point of saturation at any temperature, and for calculating the evaporation at any temperature and humidity. The latter formula is:

$$E=\left[(2.72)^{\frac{x}{11.05}}-\frac{z}{12}\right](0.34\,\text{lines}),$$

where E is the evaporation in lines in 24 hours at the temperature x of De Luc's thermometer, and in air which contains z cubic lines of water in the cubic foot.

1812.

Carradori, Gioachino.

Dell' evaporazione del ghiaccio e della neve. Gior. fis. chim., 1812, **5**:203–8.

Upholds the theory of the affinity of air and water, and that evaporation is a combination of molecules of water with "la materia del calorico termico," i. e., the "element" of fire. When water is changed to ice, the affinity of cohesion or aggregation, is changed to chemical affinity or composition. More force is required to evaporate ice than water, because of this chemical affinity.

1813.

Leslie, John.

A short account of experiments and instruments depending on the relations of air to heat and moisture. Edinburgh. 1813. p. 178. 1 pl. (See Brandes, 1823.)

Discusses the cooling produced by evaporation, and the different methods of cooling water, etc., employed by people living in hot countries. Describes a differential thermometer used as a hygrometer, consisting of two glass air chambers connected by a tube containing sulfuric acid (H_2SO_4). His atmometer is a thin ball of porous earthenware, 2 or 3 inches in diameter, with a small neck which is cemented to the lower end of a long and rather wide closed tube, graduated so that each division corresponds to an internal section equal to a film of liquid that would cover the outer surface of the ball to the thickness of 1/1000th part of an inch. In still air the indications of the atmometer and hygrometer were found to have the following relation: 1/20 of a hygrometer degree = 1/1000 inch of evaporation.

1814.

Vassali-Eandi, A. M.

Saggio di un trattato di meteorologia, memoria ricevuta li 19 Dic., 1814. Mem. soc. ital. sci., **17**:230-55.

A general account of meteorological instruments which includes a description of an atmidometer (p. 242).

1816.

Bellani, Angelo.

Riflessioni critiche intorna all' evaporazione, colla descrizione di un nuovo atmidmometro. Gior. fis. chim., 1816, **9**:102–14, 188–206, 250–62, 417–46. Abstract in Bibl. ital., no. 6, Milan, 1816. Translation of abstract in Bibl. univers., 1816, **2**:153-9.

Discussion of work by Leslie and others concerning the cold produced during evaporation. Reviews general laws and theories of evaporation as explained by Saussure, Lavoisier, Cotte, Gay-Lussac, Dalton, Flauguerges, etc. Holds with Kirwan and Richmann that the temperature of the air in contact with the water has considerable influence on the rate of evaporation. According as the temperature of the air is equal to, warmer than, or colder than the water the evaporation will be slow in the first case, nothing in the second, and rapid in the third. Quotes from ancient writers on the subject.

Thilo, Ludwig.

Ueber das Verhältniss der Ausdünstung auf dem Meere und auf dem Lande. Arch. Med. Aarau, 1816, **1**:250–6.

1818.

Schön.

Die Witterungskunde in ihren Grundlagen. Würzburg. 1818.

Discusses methods of measuring evaporation and experiments of Musschenbroek (see Cotte, 1774, and Saussure, 1789).

1820.

Anderson, Adam.

Description of a new atmometer. Edinb. phil. jour., 1820, **2**:64–7. Translated in Jour. Chem. Phys., 1820, **28**:326–8.

Presents objections to the ordinary shallow dish for ascertaining the "dissolving power" of the air, and also to Leslie's porous bulb atmometer. The latter is objectionable on account of the impossibility of using it in frosty weather and during showers, when rain is forced into the interior.

Anderson proposes an instrument which consists of an hermetically sealed system of glass bulbs and tubes containing only alcohol and its vapor, and so arranged that when the two bulbs are at different temperatures the liquid contained in the one bulb will be condensed in a second bulb and collected in a graduated tube attached to the latter. The condensing bulb is covered with wet silk or paper and evaporation therefrom cools the condenser to a temperature below that of the other bulb. The amount of alcohol collected in the graduated tube is a measure of the amount of evaporation during the corresponding time period. The apparatus is inverted to bring the distilled alcohol again into the original bulb. A scale was made for the instrument by comparing its operation with the amount of water lost from a free water surface.

Bellani, Angelo.
Descrizione di un nuovo atmidometro per servire di continuazione e fine alle riflessioni critiche intorno all' evaporazione. Gior. fis. chim., 1820, **3** (decade 2):166–77. Also reprinted, Pavia, 1820.

The evaporating surface of this instrument consists of a porous clay disc which closes the mouth of a metallic vessel connected thru a stop-cock with a second vessel which has a hinged cover. The first vessel is also connected laterally with a horizontal graduated glass tube of small bore having its free end open to the air. The second vessel is so placed that when filled its water level is not higher than that of the clay disc, but is considerably higher than the graduated tube. The whole system having been filled with distilled water and the stop-cock closed, evaporation from the clay surface removes water from the primary vessel and air enters the open end of the glass tube, forcing the meniscus backward at a rate which indicates the rate of evaporation. When the water meniscus approaches the attached end of the glass tube the tube is refilled by opening the stop-cock between the two vessels.

1823.

Brandes, Heinrich Wilhelm.
Uebersetze aus d. Engl. ins Deutsche u. commentirte: Leslie—Kurzer Bericht von Versuchen u. Instrumenten, die sich auf d. Verhalten d. Luft zur Wärme u. Feuchtigkeit beziehen. Leipsic. 1823. 8vo.

(See Leslie, 1813.)

Vassali-Eandi, A. M.
Descrizione di un nuovo atmidometro per misurare l'evaporazione dell' acqua, del ghiaccio, e di altri corpe a varie temperature. Ricevuta Aprile 29, 1823. Mem. soc. ital. sci., 1823, **19**:347–53.

The author describes a sensitive balance with a thermometer suspended from one end of its beam and dipping into the cup containing the substance whose evaporation is to be studied. He emphasizes the fact that two atmometers to be compared must be exposed under exactly similar conditions.

Vassali-Eandi, A. M.
Nota sopra le straordinarie variazioni del barometro, sopra il massimo grado di caldo e di freddo, la quantitá della pioggia, della neve, e dell' evaporazione, che si osservarrono nel 1821, con alcuni cenni sopra le qualitá dell' annata. Mem. r. accad. Torino, 1823, **27**:xli–xliv.

The evaporation for the last nine months of the year 1821 was observed to be 47 inches, 5.3 lines, while the rainfall for the entire year was 36 inches, 11.9 lines.

Walker, Ezekiel.
Philosophical essays selected from the originals printed in the philosophical journals between the years 1802 and 1817. London. 1823. 8vo.

1824.

Daniell, John Frederic.
On evaporation. Quart. jour. sci., 1824, **17**:46–61. Also in Notiz. Geb. Nat. u. Heilk., 1825, **10**: col. 65–73. See also Boston jour. phil. arts, 1824–5, **2**.39–50.

Distinguishes three conditions under which evaporation occurs: (1) When the temperature of the evaporating liquid is such as to produce vapor having a pressure equal to that of the atmosphere, that is, when it boils. (2) When the temperature of the liquid is above that of the surrounding air but below its own boiling point. (3) When the temperature is below that of the atmosphere. Considers (3) at some length. Describes experiments on evaporation from water in almost absolutely dry air (under the bell-jar with sulfuric acid), also under varying pressures (by means of the air-pump). In the latter case there was an increase in evaporation with decrease in pressure, and under yet greater rarefaction the water froze.

1825.

Bostock. John.
On evaporation. (Letter to J. F. Daniell.) Quart. jour. sci., 1825, **18**:312–7. See also Notiz. Geb. Nat. u. Heilk., 1825, **10**: col. 84–5.

The quantity of water evaporated from a free water surface of small dimensions was determined by weighings at short intervals, accompanied by observations on the temperature of the air and water, barometric readings, direction of the wind, and general weather observations. The tabulated results are followed by some discussion of the relative evaporation at different seasons of the year, under different barometric pressure, different temperatures, etc.

Prinsep, J.
Description of a pluviometer and an evaporometer constructed at Benares. Asiatic researches, 1825, **15**: (app.), xiii–xv.

He describes and figures an atmometer consisting of an exposed cup connected with a graduated tube of smaller diameter and at a lower level, this tube being supplied with a piston for driving water into the cup. The instrument is operated by first filling the tube to the standard level and then forcing water by means of the piston, into the cup from which it is in like manner withdrawn to standard level at the end of a given time, note being made of the difference in the position of the piston at the beginning and end of the operation. The ratio between the diameters of the cup and the tube gives the magnification of the observed loss.

1826.

Schübler, Gustav.
Beobachtungen über die Verdünstung des Eises. Naturw. Abh., 1826, **1**:211–8. Also general conclusions in Quart. jour. sci., 1829, **1**:187.

A table of observations of evaporation from January 1 to February 28 shows the amount lost from a surface of ice or water, the average temperature of the period, the average relative humidity, and the average height of the barometer at 55° F. During certain dry, cold weather the evaporation from ice in twenty-four hours was twice as great as from an equal surface of water in the middle of February during mild, cloudy weather. From these observations it is concluded that "evaporation of ice is far more considerable than has been supposed, and that in certain natural circumstances it may even surpass that of water."

1827.

Hällström, G. G.
De hygrometrico aëris statu tempore aestivo anni 1826 observato Aboa. (Diss. acad.) Aboae. (Abo, Finland), 1827. 4to.

Hällström, G. G.
Observationes circa evaporationem hieme proxime elapsa institutae. (Diss. acad.) Aboae. (Åbo, Finland), 1827. 4to.

Klaproth.
Sur l'évaporation de l'eau à une haute température. Ann. chem. et phys., 1827, **35**:325–9.

Experiments with water drops on a very hot metal surface much above the boiling point of water, showed that the hotter the metal the less rapid was evaporation.

Meikle, Henry.
Remarks and experiments relating to hygrometers and evaporation. Edinb. new phil. jour., 1827, **2**:22–32.

He presents some experiments and formulas connected with the use of the hygrometer as a measure of evaporation.

Pouillet.
Mémoire sur l'électricité des fluides élastiques, et sur une des causes de l'électricité de l'atmosphère. (Lu à l'acad. des sci., le 30 Mai, 1825.) Ann. chim. et phys., 1827, **35**:401–20.

The author describes experiments which show that the electricity accompanying vaporization is due to the more or less intense chemical action which takes place between the elements of the liquid and the vessel which contains it. This fact is considered proof that the electricity of the atmosphere can not have the origin which Volta is said to have assigned to it, i. e.. the natural evaporation from land and sea.

1828.

Schrön, Hermann Ludwig Friedrich.
Beschreibung, Gebrauch und Eigenschaften des Hyetometers und Atmometers. Met. Jahrb. Jena, 1828, **6**:135–44.

1829.

———
Experiments on evaporation made in the vicinity of Calcutta. Glen. sci., 1829, **1**:286–90.

In connection with the manufacture of salt at Ballyaghat near Calcutta, the rate of evaporation from enclosed tanks of from 150,000 to 850,000 square feet area and 3 to 4.5 inches depth, was studied. The experiments being on such a large scale many sources of error were necessarily considered. After discussing and allowing for these, the conclusion is reached that the evaporation rate for this place is at least as follows: January, 3 inches; February, 5 inches; March, 7 inches; April, 9 inches; and May, 9 inches.

———
Experiments on evaporation performed at Vera Cruz in 1818–20. Glen. Sci., 1829, **1**:335–7.

These experiments on evaporation from water are compared with those near Calcutta, described in the preceding paper. Variations are shown in the amount of evaporation according to the different dishes used and their exposure. To this is subjoined a note giving the results of four years' observations [by the Editor ?] of the evaporation at Benares [Oriental Magazine, 1827, (?)], as follows:

	December and January.	March.	April.	July.
Mean temperature..................degrees F..	62.3	79.4	91.1	84.4
Depression of wet bulb ....do	6.0	16.3	20.3	2.0
Monthly evaporation...................inches..	2.55	7.3	13.9	3.0

Dalton's formula applied to these figures would give about one and one-eighth times the amount of evaporation actually observed.

1830.

Anderson, Adam.
Evaporation. Edinb. Encyc., 1830, **9**:217–21.

The author describes in detail Dalton's experiments on the evaporation from soil and water (Dalton, 1805, 2d title]. He cites Duluc, 1792; Dalton, 1802; Saussure, 1783; Murray on Hygrometry in Murray's Chemistry, vol. 2, p. 705; and Doctor Wells on Dew. The latter attempted to show that the ice formed in porous pans at Bombay is not due to evaporation, but to radiation, that the water may, in fact, be increased by dew.

Dove, Heinrich Wilhelm.
Notiz über die Verdampfungskälte. Ann. Phys., Leipsic, 1830, **19**:356.

The cooling effect produced by evaporation from a thermometer bulb moistened with ether is shown to be accentuated when the ether vapor is absorbed by sulfuric acid as it is formed.

Muncke, G. W.
Geographie nebst Atmosphärologie. Heidelberg. 1830. p. 446–9.

Review of the literature of "atmospherology," including the work of Saussure, Gregory, Musschenbroek, Richmann, Wallerius, Lambert, Cotte, Bellani, and others.

Schübler, Gustav.
Grösse der wässerigen (Ausdünstung) im Jahre 1828. Jour. Chem. Phys., 1830, **58** (J. 28):208–9.

1831.

Holbrook, Josiah.
Evaporation. Scientific Tracts, Boston, 1831, **1**:151–4, 257–80.

General discussion of evaporation and the cold produced by the process.

Schübler, G.
Grundsätze der Meteorologie in näherer Beziehung auf Deutschlands Klima. Leipsic. 1831. p. 65–75.

General discussion of the methods of measuring, and the factors influencing the rate of evaporation. A table compares the annual evaporations at Rome, Rochelle, Manchester, Würzburg Tübingen, etc. The effects of temperature and wind on evaporation are also summarized in separate tables. The author then discusses the application of the amount of evaporation to the determination of the dew-point and the moisture content of the air. Studies of evaporation from soil and plants are reviewed and a table shows the relation, at different seasons, of the evaporation from the soil to that from water surfaces. Another table compares the daily evaporation from grass with that from water, and includes average temperatures and wind directions. The grass is seen to have evaporated much more than the free water surface.

1832.

Bellani, Angelo.
Sul moto molecolare dei solidi, e sul limite dell' evaporazione. Poligrafo, 1832, **10**:161–70.

Ideler, Iulius Ludovicus.
Meteorologia veterum Græcorum et Romanorum. Berlin. 1832. p. 87–95.

Cites references to evaporation in the writings of Hippocratus, Aristotle, etc. They were apparently aware of the cooling due to evaporation thru porous vessels containing water, etc.

1836.

Bischof, K. G. C.

Einige physikalische und chemische Beobachtungen in den Schweizer Alpen.—1. Ueber die Verdünstungskälte in der Nähe von Wasserfällen. Ann. Phys. and Chem., 1836, **37**:259–61.

Observations of temperature in the immediate neighborhood of waterfalls and at some distance from them show the cooling effect produced on the surrounding air by the evaporation of the mist.

Kämtz, Ludwig Friedrich.

Lehrbuch der Meteorologie. Leipsic. 1836. p. 344.

Gives a general discussion of the subject.

Murphy, Patrick.

Meteorology. London. 1836. p. 82–91.

Ridicules the theory of the solution of water vapor in air, upholding that evaporation is an electrical decomposition of water into oxygen and hydrogen. Quotes Bertholon de Saint-Lazare (1787) at some length in support of this view.

1837.

Howard, Luke.

Seven lectures on Meteorology. Pontefract, England. 1837. p. 69–72.

Describes the process of evaporation and concludes that, on the whole, the amount evaporated must be equal to the rainfall, "the one being the source of the other." Affirms the rate of evaporation to be dependent on temperature and wind velocity and states that a common rate per day from a freely exposed water surface is 1/100 to 1/10 inch in winter, 2/10 to 3/10 inch in summer. A table of the monthly evaporation near London from 1807 to 1815, shows an average total for the year of 30 75 inches.

He considers that the best instrument for measuring evaporation is a "shallow, metallic cistern" provided with a scale of three diagonals, engraved on an oblong plate of glass, the divisions of the scale to be 1/10 inch apart, and the descent in proportion of 1/100th to each division.

Klee, Franz.

Prüfung der Lehre vom Druck der Luft, nebst einer neuen Theorie über die Verdünstung und Bildung der Niederschläge in der Atmosphäre. Mainz. 1837. 8vo.

Pouillet.

Éléments de physique expérimentale et de météorologie. Paris. 1837. 2 vols. 8vo. See **1**:261, 291, 303–6, 555 et seq.; and **2**:629–30.

Pouillet supports a theory of evaporation agreeing in the main with that of Dalton, [Dalton, 1801 and 1802, 1st title]. The rate of evaporation depends, not only on the movement of the air, but on the difference between the pressure of the vapor forming and that of the vapor already formed in the air. He quotes Dalton's law. Evaporation is also proportional to the extent of surface exposed. In discussing the cold produced by evaporation, the author states that 1 grain of water vapor, formed by evaporation, has absorbed a quantity of latent heat capable of raising 500 grains of water 1° in temperature. In volume 2 it is maintained that atmospheric electricity results from the chemical segregations accompanying evaporation from the surface of the earth.

1838.

Espy, J. P.

Experiments on spontaneous evaporation. Franklin inst. jour., 1838, **22**:74–5.

He describes simple experiments with evaporation of water from porous pots and tumblers sunk in the ground, from moist earth, and from wet towels in motion and at rest; and gives the accompanying temperatures of the air and the dew-point.

Leslie, J.

Treatises on various subjects of natural and chemical philosophy. Encyclopedia Britannica. Edinburgh. 1838.

In the chapter on Meteorology, p. 402–537, the porous clay atmometer is described as in his paper of 1813. A general review of the theoretical side of the subject includes the vesicular theory held by Halley, Leibnitz, Musschenbroek, Desaguliers, Kratzenstein; and the advance made in 1750 by Hamberger, who attributed evaporation to a real solution of moisture in the air, and by Le Roy who followed along the same lines. The experiments of Wallerius, Musschenbroek, Richmann, Saussure, and Kirwan are given critical attention. It is maintained that the full cooling effect on the wet-bulb thermometer may be obtained without the whirling practised by Saussure.

1840.

Kämtz, Ludwig Friedrich.

Vorlesungen über Meteorologie. Halle. 1840. p. 69, 392.

A general discussion.

Muncke, G. W.

Verdünstung. Gehler's Physikalisches Wörterbuch. Leipsic. 1840. **9** (pt. 3): 1720–50.

The article Verdünstung gives a survey of the literature of the subject up to 1840, including the work of Dalton, Schübler, and others.

1842.

Dausse.

De la pluie et de l'influence des forêts sur les cours d'eau. Ann. ponts chauss., 1842, **3** (2): 184–209, 197–201.

In discussing the effects of evaporation and its immense rôle in nature, the author presents tables of rainfall and evaporation in France, together with the average monthly height of the Seine. The object is to show that the greatest evaporation follows close upon the greatest rainfall, but that the highest stage of the Seine occurs when the rainfall and evaporation are least. It is calculated that evaporation reduced the volume of water in the Seine from 7 to 3, or more than half, and that the reduction would not have been as great if the banks had been forested instead of being bare as was the case at that time.

Rowell, G. A.

On the retardation of evaporation by electric insulation. Proc. Ashmol. soc., 1841, **23**:7. Also Phil. mag., 1842, **20**:45–6.

Experiments on the relative evaporation of water from an insulated vessel and an uninsulated one, showed an excess of evaporation from the latter of 14 dwts., 9 grains. The author belives that if complete insulation could be maintained, no evaporation would take place at moderate temperatures.

Saigey.

Petite physique du globe. Paris. 1842. p. 108–12.

The yearly evaporation at Paris from circular dishes, 30 or 60 centimeters in diameter, and 10 or 20 centimeters deep, is stated to be about 800 mm. when the dishes are half filled with water.

1844.

Baily, J.

On the Isthmus between the Lake of Grenada and the Pacific. Jour. roy. geog. soc., 1844, **14**:127–9.

An incidental remark in this article states that, according to various calculations, the average annual evaporation in inter-tropical climates amounts to 39 inches.

Liénard.

Sur le mélange de l'eau de mer à l'atmosphère. Mém. soc. agr., Bayeux, 1844, **2**:289–90.

1845.

Daniell, John Frederic.

Elements of Meteorology. London. 1845. 2 v. Volume 2, p. 25, 66, 220, 236.

According to this author, "the hygrometer may be applied to indicate the force and quantity of evaporation." Refers to Dalton's law that the quantity of water evaporated in a given time, bears a definite relation to the force of vapor at the same temperature. A table shows the full evaporating force of every degree of temperature from 18° to 85° F. Discusses the conditions and laws of evaporation from water and soil.

Laidlay, T. W.

Observations on the rate of evaporation on the open sea; with a description of an instrument used for indicating its amount. Jour. Asiat. soc. Bengal, 1845, **14**:213–6. Also abstracted by Blanford, 1877.

Leslie's atmometer is described and criticized as lacking simplicity of construction and use. An instrument of his own invention consists of a small glass tube, closed at both ends, at the lower end by means of a plug of some porous substance as wood. The tube is filled with distilled water and attached to a scale upon which the amount lost from the tube by evaporation from the surface of the plug may be observed. Observations were made with this instrument hung in the shade but freely exposed to the wind, on board ship between England and Calcutta. The daily average, from lat. 37° 15′ S. to lat. 24° 25′ S., was 0.398 inches, and thru the Tropics 0.809 inches. A table of von Humboldt's results of observations in

similar regions with Deluc's hair hygrometer, reduced by d'Aubuisson's formula, gives a much smaller rate. Laidlay explains the discrepancies by the fact that Deluc's hygrometer takes no account of the important agency of the wind. Laidlay's instrument, suspended in the shade on an open verandah in Calcutta, gave a daily average evaporation of 0.507 inches for the year.

Parkes, Josiah.

On the quantity of rain compared with the quantity of water evaporated from or filtered thru soil; with some remarks on drainage. Jour. roy. agr. soc., 1845, **5** (1st ser.): 146–58.

The author describes experiments by John Dickinson, to determine the percentages of rainfall which percolate thru the soil or evaporate from its surface. Besides a rain gage, he employed for this purpose a cylinder filled with soil and sunk in the ground, this cylinder having a false perforated bottom and a receptacle beneath for collecting the percolation water. This lower receptacle communicated by a small tube with a second vertical cylinder below the level of the other, the diameter of the second bearing some convenient ratio to that of the first. The percolation water is measured by means of a graduated stem borne on a float in the second cylinder. The evaporation includes that due to the plant growth on the surface of the soil. The results of eight years' observations, 1836–43, show the annual evaporation to be 57.5 per cent of the rainfall, or 15.3 inches. Other estimates are quoted.

Regnault, Victor.

Etudes sur l'hygrométrie. Compt. rend., 1845, **20**:1127–66, 1220–37. Also Ann. chim. et phys., 1845, **15** (3d ser.):129–236. Translated from Comptes rendus in Ann. Phys. und Chem., 1845, **65**:135–58, 321–60. Also Sci. mem., 1846, **4**:606–60.

The first part (p. 1128–66) contains: (1) a table of the varying tensions of water vapor in saturated air at a series of different temperatures; (2) a table of the varying densities of water vapor in saturated air at different temperatures; (3) a table of similar densities in air of different degrees of humidity below saturation. The second part (p. 1220–37) describes methods of determining the relative humidity of the air: (1) the chemical method; (2) that founded on the changes occurring in hygroscopic materials; (3) that of the condensation hygrometer; (4) that founded on the indications of the wet and dry-bulb thermometers. This is followed by formulas and tables.

Rowell, G. A.

On the phenomena of evaporation, the formation and suspension of clouds, etc. Edinb. new phil. jour., 1845, **38**:50–6. Reviewed in Franklin inst. jour., 1847, **44**:340–3.

The author is of the opinion that vaporization is produced by an increase in the electrical charge of the water particles and that condensation is due to a decrease in or removal of this charge. Thus evaporation is considered a phenomenon of static electricity. This theory is elaborated at length and a number of meteorological phenomena are considered from this standpoint.

1846.

Ludlow.

Observations on evaporation made at the Red Hills, near Madras, in 1844. Madras jour. lit. sci., 1846, **13**:87–93. Also quoted by Blanford, 1877.

By careful experiments he compared the rate of evaporation from an evaporator floated on the surface of a large tank, with that from an evaporator on land some distance from the tank, and found one-fifth less evaporation from the tank exposure than from the land exposure during the hottest months of the year. The results show a gradual increase in the ratio between the two, but this is at least partially accounted for by the fact that the depth of the water in the tank diminished about 6 feet from April 1 to August 20. He concludes that "depth is important in such reservoirs, the amount of evaporation not only increasing with surface but inversely as the depth." The rainfall during the period was 8 inches, the total fall in the water level of the tank was 83 inches, and the evaporation 53 inches, so that only three-eighths of the amount disappearing was available for irrigation. Tables of results, including temperature observations, etc., are given.

1847.

Daubrée, G. A.

Observations sur la quantité de chaleur annuellement employée à évaporer de l'eau à la surface du globe, et sur la puissance dynamique des eaux courantes des continents. Abstract by the author, Compt. rend., 1847, **24**:534–50. German translation in Ann. Phys. und Chem., 1847, **71** (3d ser.): 173–5.

In calculating the amount of heat annually consumed in evaporation, the total evaporation is considered equal to the total rainfall on the surface of the earth, which is estimated as 703,435 cubic kilometers, equivalent to a layer of water having a uniform depth of 1.379

meters over the entire earth. This amount of evaporation consumes nearly one-third of the heat annually received from the sun. The total energy of evaporation is estimated as more than 1,800 times that manifested by the flowing waters of the earth, the latter approximating 9,000 million horse-power.

Glaisher, James.

Hygrometrical tables, containing temperature of the dew-point; the elastic force and weight of vapor; degree of humidity; weight of air, etc.; corresponding to all readings of the dry- and wet-bulb thermometers between 10° and 90° [F.]. With directions for using, and explanation of the theory and uses of the dry- and wet-bulb thermometers. London. 1847. First edition. 8vo.

Babinet, J.

Note sur un atmidoscope. Compt. rend., 1848, **27**:529–30.

He describes an instrument somewhat similar to Leslie's (1813), in which evaporation takes place from the surface of a reservoir of porous clay filled with water. The reservoir is supplied from a vertical tube connected therewith and at a lower level, and the evaporation is measured by the lowering of the water level in the latter. The advantage is claimed for this instrument over the ordinary hygrometer, of being influenced by the movement of the air and of registering the integrated effect from the beginning of the experiment.

Cartillon, C.

Synthèse de quelques météores dépendents du phénomène de l'évaporation de l'eau. Trans. Roy. soc. arts, sci., Mauritius, 1848, **2**:97–118.

Rowell, G. A.

On the cause of evaporation, rain, hail-stones, and the winds of the temperate regions. Rpt. Brit. assoc. adv. sci., 1847. (Notices p. 41.)

Repeats his hypothesis expounded in 1845.

1848.

Vallés, F.

Projet de deséchement et d'irrigation du lac de Grand-Lieu. Ann. ponts chauss., 1848, **16**:158–251.

Dissusses, p. 226–31, the relative intensity of evaporation. Results obtained from 1782–1801 by Calandrelli and Conti are quoted from de Prouy's work on the Pontine marshes (?). A table gives the annual average evaporation as 2.362 meters and the ratios according to the seasons. The daily evaporation at Nantes is calculated at 0.005 meters.

1849.

Buist, G.

On the saltness of the Red Sea. Trans. Bombay geog. soc., 1849, **9**:38–48.

It is stated incidentally (p. 39), that the temperature of the surface of the Red Sea varies from 65° to 85° F., that the difference between the wet-bulb and dry-bulb is from 25° to 40° F., and that the average evaporation at Aden is 8 feet per year.

Charnock, J. H.

On suiting the depth of drainage to the circumstances of the soil. Jour. roy. agr. soc., 1849, **10**:507–19.

In connection with percolation experiments, from 1842 to 1846 inclusive, the following average annual data are presented in tabular form: (1) rainfall, 24.6 inches; (2) evaporation from a water surface freely exposed to sun and wind, 35.05 inches; (3) evaporation from water shaded from sun but exposed to wind, 23.35 inches; (4) evapóration from drained soil, 19 76 inches; (5) evaporation from saturated soil, 32.68 inches. Dalton's observations (1802, 2d title) in similar experiments are quoted, together with those of Dickinson (Parkes, 1845).

Harting, Pieter.

Drie nieuwe physische wertingen-Hygrometer, Drijfbalans, en Atmometer of Verdampingsmeter. Utr. Anteek. prov. genoots., 1849, (—):6–18.

Norton, W. A.

On the diurnal variations in the declination of the magnetic needle, and in the intensities of the horizontal and vertical magnetic forces. Amer. jour. sci., 1849, **8**;350–64. Abstracted by Ramsay, 1884.

He attributes the daily decrease in the horizontal force of the magnetic needle, between 4 and 10 a. m., to the evaporation of the dew or rain that has fallen during the night.

Schübler, G.
Grundsätze der Meteorologie in näherer Beziehung auf Deutschlands Klima. Leipsic. 1831. First Edition. Neu bearbeitet [2d Edition] von G. A. Jahn. Leipsic. 1849.

Evaporation is discust on p. 72–80.

1850.

Kunzek, August.
Lehrbuch der Meterologie. Vienna. 1850.

Gives definitions of Verdünstung and Verdampfung (p. 95), and discussion of evaporation in general (p. 96).

Lenz, H. F. E.
Beitrag zur Bestimmung der in St. Petersburg verdünstenden Wassermenge, Mél. phys. et chim., 1850, **1**:226–38. Also Bul. acad. imp. sci., 1851, **9**:col. 86–94.

The loss of weight by evaporation from two small brass dishes of water, was observed during the winter of 1849–50. The apparent disagreements between the evaporation rate on the one hand, and the temperature and humidity on the other, are explained by wind conditions, the importance of which as a factor influencing evaporation is emphasized. Comparisons of the evaporation from ice with that from freezing water, show the latter to have the higher rate. A curve of bi-hourly readings of evaporation is seen to follow the daily march of temperature. He also compares the diurnal and nocturnal rates of evaporation.

Vallés, F.
Note sur une exception remarquable que présente la mesure de l'évaporation naturelle à Saint-Jeane-de-Losne, Dijon, Pouilly et La Roche-sur-Yonne. Ann. ponts chauss., 1850, **20**:383–93. Abstract in Rogers Field, 1869.

According to this paper hydraulic engineers have generally considered the amount of evaporation in France to be much greater than the rainfall. Seven years' observations on the Canal de Bourgogne at the places mentioned show, however, that only once did the evaporation exceed the rainfall, and that the average evaporation is less than half what it had hitherto been considered. (See Tarbé, 1852, for similar results.)

1851.

Charié-Marsaines.
Sur les travaux de la rigole dérivée de l'Yonne pour l'alimentation du point de partage du canal du Nivernais. Ann. ponts chauss., 1851, 1 (3d. ser.):289–333.

In Note A, p. 320–4, are described observations on evaporation from the Languedoc canal for the 320 days that the navigation of the canal annually lasts, and the result showed a loss of 0.812 meter. The results obtained by Halley, Sedileau, and Cotte are quoted, and the ratio between the evaporation at different seasons of the year, as estimated by Vallés and Cotte, is discust.

Espy, James.
Third Report on Meteorology to the Secretary of the Navy. Washington, 1851.

He reports, p. 19, experiments on the relative lowering of temperature produced by the evaporation of sea water and fresh water from the bulb of a thermometer. An equal depression was thought to have been observed in both cases, wherefore it is assumed that evaporation from sea water is the same as evaporation from fresh water under the same circumstances.

Miller, J. F.
On the relation of the air and evaporation temperatures to the temperature of the dew-point, as determined by Mr. Glaisher's hygrometrical tables founded on the factors deduced from six-hourly observations made at the Royal Observatory, Greenwich. Phil. trans., 1851,(—):141–8. Notice in Phil. Mag., **1** (4): 168.

A comparison of dew-points determined by the use of Daniell's hygrometer and the wet-and dry-bulb thermometers proved the extreme accuracy of Glaisher's tables. Experiments on the evaporation of water in a small copper vessel exposed to sun and wind, but partially sheltered at night and in wet weather, showed an annual average for the six years, 1843–8, of 30.011 inches with an average annual rainfall of 45.25 inches.

Miller, J. F.

Synopsis of meteorological observations made at Whitehaven, Cumberland, in the years 1848–50. Edinb. new phil. jour., 1848, (—): 55; 1849, (—): 53; 1851, (—): 234.

Includes observations on evaporation.

1852.

Newman, J.

Description of a new evaporating gage. Phil. mag., 1852, **4**(4):534–5.

Describes an atmometer similar in design to that of Prinsep, 1825.

Regnault, V.

Études sur l'hygrométrie. Compt. rend., 1852, **35**:930–9. Ann. chim. et phys., 1853, **37**:257–85. Translated from Compt. rend. in Ann. Phys. und Chem., 1853, **88**:420–32.

Repeats statements of 1845, and develops formulas for the psychrometer.

Tarbé.

Note sur la mesure de l'évaporation à la Roche-sur-Yonne, pendant les années 1846 à 1850. Ann. ponts chauss., 1852, **3**:249–52. Abstracted by Rogers Field, 1869.

The evaporating basin employed in these experiments was made of masonry 8 feet 2¼ inches square and 1 foot 4 inches deep, and lined with zinc. Readings were taken once a month and the basin refilled to a standard level on a graduated scale fixt to one of the inside faces. The evaporation from this basin was found to be nearly equal to the rainfall, thus confirming the results obtained by Vallés, and contrary to previous observations.

1853.

Aymard, Maurice.

Sur les irrigations de la Metidja et les cours d'eau de l'Atlas. Ann. ponts chauss., 1853, **6**:46–131.

Experiments to determine the effect of air movement upon evaporation gave a daily average of 0.000659 meter and 0.000471 meter for the check. The following comparable figures are quoted from de Gasparin's Cours d'agriculture, vol. 2, p. 306: 0.000437 meter per day at Orange; 0.000430 meter at Cavaillon; 0.000508 meter at Arles; 0.000400 meter at Marseilles; 0.000491 meter at Rome.

Clark.

On the amount of evaporation from two surfaces of water, each 9 square feet in area, the one under cover, the other open to the sky and on all sides; and the fall of rain received in a vessel of the same extent in the year 1852 in the Royal Arsenal at Woolwich. Athen., 1853 (—): 198.

The level of the evaporating surface is here observed by means of a float attached to a fine thread wound about a cylinder which is connected with an index hand moving over a dial. The dial is graduated in convenient units for measuring evaporation in terms of the subsidence of the evaporating surface. Another thread bearing a balancing weight is attached to the cylinder and is wound in the opposite direction, so that when the water surface rises, as during rain, the movement of the index is reversed. Results for the year show 10.3 inches evaporated from a water surface under a shed, and 25.8 inches from one freely exposed to the weather. The rainfall for the year was 31.8 inches, on 165 days.

Drian, Aimé.

Note sur l'évaporation négative. Ann. soc. agr. Lyon, 1853, **5**: 416–21.

Investigations show that when the temperature of the dew-point is higher than that of the evaporating surface atmospheric moisture is deposited upon that surface. This process is termed "negative evaporation."

Fournet, J.

Remarques sur "Note sur l'évaporation négative" par Aimé Drian. Ann. soc. mét., 1853, **1**: 234–7.

It is pointed out that whenever the temperature of the water in the evaporating dish is below that of the dew-point, while that of the air is higher, condensation instead of evaporation takes place. The most favorable season for observing this phenomenon is said to be in October, and a table of results obtained October 20–25 [1853?] is given. Observations with the condensation hygrometer, as well as with the thermometer, were found to run parallel to those of the evaporation. This paper also reviews the work of Vignon, 1853.

Marcet, Francois.

Recherches sur l'évaporation des liquides. Arch. sci. phys. et nat., 1853, **22**:305–28. Abstract by the author in Compt. rend. 1853, **36**:339–41. Also abstracts in "London Repertory of Patent Inventions," Jan., 1854; in Franklin inst. iour., 1854, **57**:278; Dingler's Polytech. Jour., **128**:51–2; and Zeits. f. Naturw., **1**:218–9. Translation from Bibl. univ., April, 1853, in Phil. mag., **6** (4):385–7; also Ann. Phys. und Chem., Ergänzungsband, **4**:345; Cosmos, 1853, **2**:358–9.

These researches were undertaken as the result of a letter by August de la Rive published in Comptes rendus for October, 1851. This letter explained former glaciation as due to the cold of evaporation experienced by recently formed land masses during the evaporation of the water which covered them. This cold is supposed to have been very intense on account of the siliceous materials mingled with the water.

Marcet concludes from his experiments that: (1) The temperature of the evaporating surface is always lower than that of the atmosphere, the difference depending on the temperature of the latter. (2) The temperature and rate of evaporation of such liquids as water and alcohol vary according to the nature of the vessel in which they are contained. (3) The surfaces being identical, the mass or depth of the liquid seems, within certain limits, to favor evaporation. (4) A salt solution similar to sea water evaporates less rapidly than freshwater, consequently its temperature is lowered less by its evaporation. (5) Water mixt with sand so that a layer of water floats above the saturated sand, evaporates more than water alone and consequently becomes colder by evaporation, the difference in temperature rarely exceeding 0.5° C. The author concludes that his experiments tend to confirm the opinion of de la Rive concerning the cause of the appearances of ancient glaciers.

Vallés, F.

Nouvelles remarques sur la phénomène de l'évaporation naturelle. Ann. ponts chauss., 1853, **5**:269–80.

The author attempts to establish more firmly his statement of 1848, that the ratio of evaporation according to the seasons is 1: 2: 3: 1. This had been challenged by Charié-Marsaines, 1851, and Vallés finds so many conflicting numbers that he comes to no definite conclusion.

Vignon, E.

Notes sur des bassins d'évaporation employés dans la service du canal du Nivernais et de la rivière Yonne. Ann. soc. mét., 1853, **1**:36–40.

The atmometer used in this case was a cylindrical vessel 80 centimeters in diameter and 35 centimeters high. On one side, at 25 centimeters from the bottom, a vertical funnel connects with the interior, while on the other, at the same height, is attached a tube bearing a cock. The 25-centimeter level is marked on the inside by three vertical points. Water lost by evaporation is restored to this level thru the funnel from a graduated measuring dish, the diameter of which bears such a relation to that of the evaporating vessel that the reading is much magnified. If, owing to rain, the water rises above the 25-centimeter level, it can be drawn off by means of the cock until the three points just touch the surface of the water.

1854.

Gaugain, J.-M.

Note sur l'électricité qui accompagne l'évaporation de l'eau salée et sur l'origine de l'électricité atmosphèrique. Compt. rend., 1854, **38**:1012–15.

In experiments similar to those of Pouillet, 1837, using Volta's goldleaf electroscope and a marine salt solution, it was found that electricity is manifested exclusively during the decrepitation which succeeds the spheroidal state, the quiet evaporation which operates when the crackling has ceased never giving any sign of electricity. It was concluded, therefore, that atmospheric electricity can not be attributed to the chemical segregations which take place during the tranquil evaporation of the waters of the sea.

Gaugain, J.-M.

Sur le développement d'électricité qui accompagne l'évaporation des dissolutions aqueuses. Compt. rend., 1854, **39**:231.

Experiments with the electricity accompanying evaporation lead to a conclusion similar to Pouillet's, which ascribes the electricity to the friction between the evaporating liquid and the walls of the vessel.

Geddes, George.

Rain: evaporation and filtration. Trans. N. Y. State agr. soc, 1854, **14**:150–64.

In connection with a consideration of evaporation from soil, Henry Tracy, in a report to the Canal Board 1849, p. 17 (?), is quoted as stating that the annual evaporation in 1835 from a surface of ground near Boston was 19.43 inches; in 1837, 14.95 inches; and in 1838, 21.49 inches; the rainfall for the same years being 35.26, 26.65, and 38.11 inches, respectively. Tables of evaporation from a water surface at Ogdensburg and Syracuse are also given.

1855.

Buist, George.

On the means of determining the actual amount of evaporation from the earth's surface. Met. soc. rpt., 1855 (—):6.

Chapman.

Object of the salt condition of the sea. Phil. mag., 1855, **9** (4):236–8.

Experiments showed that the evaporation from rain water exceeded that from a 2.6 per cent salt solution by 0.54 per cent for the first twenty-four hours, by 1.04 per cent after forty-eight hours, and by 1.46 per cent after seventy-two hours. Each experiment lasted six days and resulted in an always increasing ratio as the solution became more concentrated. It is considered that this fact points to the conclusion that the salt condition of the sea is a self-adjusting phenomenon mainly intended to regulate evaporation.

Drew, John.
Practical Meteorology. London. 1855. p. 30–2, 161.

The process of evaporation, its cooling effect, and the various methods of measuring the amount are discussed. Glaisher's tables are quoted from Phil. mag., 1848:1, to illustrate the diurnal range of the dew-point and of the temperature of evaporation as shown by the wet-bulb thermometer. From one daily observation of either the monthly mean may be deduced.

Jahn, G. A.
Handbuch der Witterungskunde. Leipsic. 1855. p. 107–10, 211–13.

Discussion of methods for determining evaporation and the conditions influencing it.

Meikle, Henry.
Evaporation. Encyc. Brit., 1855, 8th ed., **9**:496–515.

Presents historical sketch of various investigations of evaporation pursued by Desaguliers, Clement, Saussure, Deluc, Dalton, Desormes, Gay-Lussac, Halley, Dobson, Dalton and Hoyle, Daniell, Anderson, Meikle, etc.

Prestel, M. A. F.
Das Vaporimeter oder die Psychrometer-Skala, etc. Emden. 1855.

1856.

Blake, W. P.
On the rate of evaporation on the Tulare lakes of California. Amer. jour. sci.., 1856, **21**(2): 365–8.

The observed evaporation from a shallow pan, sheltered from the sun but exposed to wind, showed the yearly depth of evaporation in this region to be 7 feet, 7¼ inches. A table gives the daily rate of evaporation, temperature of the air and water, with remarks on wind, etc., during the four days, August 26–9, 1853. It is concluded that evaporation from these lakes is equal to, if not greater than, the supply.

Coffin, James Henry.
Psychrometrical table: for determining the elastic force of aqueous vapor and the relative humidity of the atmosphere from indications of the wet- and dry-bulb thermometers, Fahrenheit. Washington. 1856. p. 20. Also in Smiths. misc. coll., etc. 1862, **1**.

Hopkins, T.
On certain arid countries and the cause of their dryness. Jour. roy. geog. soc., 1856, **26**: 158–73. Reviewed by Ramsey, 1884.

Treats of the rôle of vapors and their condensation in the movements of the atmosphere.

Mitchell, A.
Description of a new atmometer, or evaporometer. Jour. soc. arts, 1856, June 6. Also, London. 1856. 8vo.

Details of construction and diagrams are given of a constant-level apparatus for measuring evaporation, on the general principle of the fountain ink-stand or bird's drinking cup. The author holds that "the atmometer is a supplement to, not a substitute for the hygrometer."

Reischauer, C.
See Vogel, K. August, und C. Reischauer.

Vogel, K. August, und C. Reischauer.
Ueber ein Atmidometer neuer Construction. K. bayer. Akad. der Wiss. Munich, Gelehrte Anz., 1856, **42**: 15–6.

Two earlier forms of "atmidometer," the "atmidoscope" of Babinet and Newmann's evaporating gage are described. A new form consists of a balance bearing above one end of its beam a pan with the evaporating water, while a weight is suspended below. The other end bears a pointer, which shows on a dial the amount evaporated. This instrument has the advantage over the hygrometer that it can be left for a long time and will give the mean for the period, a result impossible to obtain with the latter unless it is read very often.

Way, J. Thomas.
On the composition of the waters of land-drainage and of rain. Jour. roy. agr. soc., 1856, **17**(1): 123–62.

Quotes Parkes, 1845, on results of Dickinson's experiments with evaporation from soil by means of the Dalton gage. Presents annual and monthly tables.

1857.

Sandeman, Patrick.
Monthly tables of daily means of meteorological elements during 11 years, commencing January, 1846, [at the] Observatory, Georgetown, Demerara, British Guiana. Greenock. 1857.

An account of intermittent observations of evaporation up to 1853, followed by columns of daily evaporation with monthly totals from January, 1853, to December, 1856. The rainfall and evaporation, in inches (?), for the respective months of 1856 is as follows:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Evaporation	4.017	4.668	5.172	4.025	2.740	2.305	2.052	1.840	3.069	3.071	2.604	2.360
Rainfall	2.019	0.963	1.655	3.055	10.232	16.705	13.230	7.806	5.804	3.145	5.776	17.336

1858.

Jenyns, Leonard.

Observations in meteorology (being chiefly the results of a meteorological journal kept for nineteen years at Swaffham Bulbeck in Cambridgeshire). London. 1858.

Discusses the effect of rainfall and humidity on the local climate, and the influence of moisture on sensible temperature. According to this author, dry weather in winter feels colder than moist. The conditions most favoring evaporation are heat, dry air, and diminished pressure on the evaporating surface. Howard's (1837) figures for daily evaporation are quoted. The relative humidity and dew-point are determined by means of Daniell's hygrometer.

1860.

Babington, Benjamin Guy.

On spontaneous evaporation. Review of a communication to the Royal Society, November 24, 1859. Phil. mag., 1860, **19**(4):314–7. Reviewed in Fortschr. der Phys., 1859, **15**:358–9.

Dissolved substances influence evaporation in various ways. The influence of different solutes may be estimated by comparing the rate of evaporation of their solutions with that of pure water. Evaporation is retarded in proportion to the quantity in solution, and does not depend on the specific gravity of the solution. In aqueous solutions of salts the retardation does not appear to depend upon the acid radical, altho it is not altogether independent of the influence of the base. With some exceptions, salts with two equivalents of an acid radical have greater retarding influence than those with one equivalent. Some salts in aqueous solution appear not to retard evaporation, and some seem actually to accelerate it.

Drew, John.

Practical Meteorology. (2d ed. edited by Frederic Drew.) London. 1860.

See Drew, 1855.

Mühry, A.

Allgemeine Geographische Meteorologie. Leipsic and Heidelberg. 1860.

On page 140 he gives a general discussion of evaporation as inflenced by humidity, seasons, time of day, and wind. Quotes Schübler's results of observations with a weighing atmometer (1826). Gives the results of Dalton's experiments showing the influence of higher temperature in increasing evaporation. Discusses geographic distribution of humidity which he regards as the most important factor influencing evaporation, especially where climates are compared.

The psychrometer is considered to be the real measure of the evaporating power of the air. Describes an atmometer similar to Lamont's (1868). It consists of a small open glass evaporator borne on a bent graduated tube which connects with a lower reservoir, the latter furnished with a second opening above closed by an air-tight cock. After filling the reservoir with water and noting the height on the scale, water is brought to the proper level in the evaporator by forcing air into the reservoir thru the upper opening and the cock is closed. After the instrument has been exposed to evaporation the cock is opened and when the water is again at the same level in reservoir and tube the change in position of the water surface on the scale of the tube shows the amount lost by evaporation.

The physiological and pathological effects of dry and moist climates enter into the discussion.

Ruinet.

Note sur l'évaporation. Ann. ponts. chauss., 1860, **20**:150–60. Abstracted by Rogers Field, 1869.

Describes observations at Dijon from 1845–52, which show a continuation of the low rate of evaporation mentioned by Vallés (1850). This recent low rate is explained as due to the difference in the size and nature of the instruments by which the phenomenon had been observed. Small basins become unduly heated and cause a much higher rate than larger ones. Were similar instruments employed the rate from the Canal de Bourgogne would probably not be so different from rates elsewhere observed. It is concluded that "the evaporation which really takes place from the surface of a large natural extent of water is far from being as great as the observations on a small scale would lead one to suppose."

Schmid, Ernst Erhard.

Lehrbuch der Meteorologie. Leipsic. 1860. p. 595–600.

Quotes Dalton's tables, as reduced by Schübler to Parisian feet and inches, showing evaporation from a square foot of water surface in a quiet, previously dried atmosphere, at different temperatures during twenty-four hours. Tables compiled from Schübler's and Kämtz's results show the yearly evaporation at 26 stations in France, Germany, England, etc., and at Cumana. The rate of evaporation shows merely a general agreement with the average temperatures of the various places. Schübler's table of the daily evaporation in the shade at Tübingen, is found to be of less value than that of Stark, who observed the daily evaporation in the sunshine at Augsburg for fourteen years. The ratio obtained from the latter observations in the sun, is two or three times higher than that from the former in the shade.

An important factor influencing evaporation is shown to be the action of ascending air currents in accelerating the propagation of water vapor into the upper regions of the atmosphere. Schübler's tables showing the effect of wind, also the results of his experiments comparing evaporatiou from moist garden soil with that from water, are quoted. (Schübler, 1826, 1831; Kämtz, 1840.)

Schulze, Franz Eilhard.
Beobachtungen über Verdunstung im Sommer 1859. (Gekrönte Preisschrift.) Rostock. 1860. 4to.

Reviewed by Kämtz, 1862.

1861.

Mühry, A. A.
Ueber ein einfaches schärfer messendes Atmometer. Ann. Phys. und Chem. (Poggend.), 1861, **113**:305–3.

The principal of measuring evaporation by reduction of surface, used by Newman and Prinsep, is more elaborately developed in this instrument which the author calls a micro-atmometer.

Reischauer, C. G.
Ueber die Abhängigkeit der Verdunstung von der Grösse der Exponirten Oberfläche. Ann. Phys. und Chem. (Poggend.), 1861, **114**:177–86. Also, Zeits. f. Naturw., **19**:331–2. Review in Fortschr. der Phys., 1861, **17**:386.

Comparison of evaporation from water surfaces of different areas exposed for four days in a closed laboratory give the following results:

Surface	100	278	450	1905
Evaporation.	100	260	448	1266

Unger, F.
Neue Untersuchungen über die Transpiration der Gewächse. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1861, **44**:181–217, 327–68.

A comparison of transpiration with evaporation.

1862.

Beardmore, Nathaniel.
Manual of Hydrology. London. 1862. p. 296, 325, 332–5.

General discussion of the process of evaporation and the difficulties of measuring it. Cites the results of Howard, Daniell, Watson, etc. Gives the tables of A. Golding, state engineer at Copenhagen, showing evaporation from water at Endrup, from short grass and from long grass during the years 1849 to 1859. Table of monthly rainfall and evaporation for the ten years, 1844–1853, at Bolton-le-Moors, Lancashire, and at Whitehaven, Cumberland. Table of rainfall, evaporation, and temperature at Little Bridy, Dorset, and at Radcliffe Observatory, Oxford. Tables of tropical evaporation at Demarara or Georgetown, British Guiana, and at Bombay.

Herschel, Sir John F. W.
Meteorology. Encyc. Brit., 2d ed., Edinburgh. 1862.

For the evaporation of water, its rate at various temperatures, p. 50; of ice and snow, p. 125; accelerated by wind and other causes, p. 50 and 125; abstraction of heat by, p. 51; electricity developed by, p. 132.

He quotes the results of Pouillet, presented to the Academy of Sciences in 1825. From experiments on the problem of the electricity developed by evaporation he concludes that the simple change of state from the solid or liquid to the vaporous of any substance is unaccompanied by electrical excitement. The evaporation of pure water or of any other substance not decomposed or partly decomposed in the act, produces no electrical excitement whatever; but when evaporation is accompanied by chemical change electricity is developed. Water evaporated from alkaline solutions carries off "resinous" and leaves behind "vitreous" electricity. The reverse is the case when water evaporates from an acid, or from neutro-saline solutions, e. g., that of sea salt, or from heated iron which it oxidizes. His final conclusion is that the immense evaporation both from sea and land, and the vital processes going on, furnish at least the chief supply of electricity to the air.

Kämtz, L. F.
Ueber Verdunstung. Dorpat. 1862. 4to. Also Repert. f. Met., Dorpat, 1862, **2**:200–3.

A general discussion of reasons for observing evaporation in the shade or in the sun, is followed by a review of the work of Schulze. The author in his own experiments to compare the rate of evaporation from pure water with that from various moist soils and from plants, used freely exposed glass vessels of equal height and surface, and the amount lost by evaporation was determined by weighing. From June 25 to the end of October the total evaporation from moist garden earth was 17.336 g., from saturated garden earth, 20.912 g., and from water, 16.448 g. Only in August was the rate from water higher than from moist soil. Saturated bog soil, with water-holding power of 170 per cent, lost 21.10 g. This excess of evaporation from the bog soil over that from water is explained by a probable small temperature difference in favor of the dark, opaque bog soil. The final conclusion is that, in general, soil covered with vegetation evaporates more than bare soil; and that the rate of evaporation from the Russian steppes is probably lower than it would be if they were covered with trees.

Krecke, —. —.

Het Klimaat von Nederland.

Gives the amount of evaporation for 1862 at Helder, Utrecht, Kniesdorp, and Oudorp. See H. W. Dove, 1864.

Lamont, Johann N.

Dalton's theory of vapor and its application to the aqueous vapor of the atmosphere. (Extr. from a letter by Lamont, dated Munich, Aug. 28, 1862, to Professor Kämtz at Dorpat), translation by W. T. Lynn, Phil. mag., 1862, **24**:350–8. Reprinted in Proc. Brit. met. soc., 1863, **1**:310–8.

Review of Dalton's (1801, 1802) theory regarding the mixture of vapor with the atmosphere. Lamont's experiments lead him to conclude that Dalton's theory, in so far as it assumes that the air and vapor existing in the same space are independent of each other, is unfounded and that in his opinion the facts are "that the air exerts a pressure upon the vapor and the vapor upon the air." The data furnished by the psychrometer are regarded as expressions of local humidity.

Mühry, A. A.

Klimatographische Uebersicht der Erde, in einer Sammlung authentischer Berichte mit hinzugefügten Anmerkungen zum wissenschaftlichen und practischen Gebräuche. Heidelberg. 1862.

A general discussion on p. 701–7.

Nowak, Alois.

Weitenweber—Mittheilungen aus einer grösseren hydrologisch-meteorologischen Studien des Herrn Dr. Nowak über das Todte Meer und ihre Verdunstung. Sitzb. k. böhm. Ges. d. Wiss. (Prag), 1862 (pt. 1): 27–30.

This is a study of the inflow and evaporation from the Dead Sea, the former being 315 inches annually and the latter only 60 inches. The excess inflow is supposed to drain into a cavity between the crust and the center of the earth, to emerge later as springs or vapors.

Schmid, E. E.

Grundriss der Meteorologie. Leipsic. 1862. p. 125, 188–9.

Ocean currents are attributed to the action of rain and evaporation. Schübler's (1831) attempts to measure the evaporation from soil and plants are reviewed. Previous observations of this phenomenon are regarded as having only a very inferior value.

Tait, Prof. [Peter G.] and J. A. Wanklyn.

Note on the electricity developed during evaporation and during effervescence from chemical action. Reprinted in Phil. mag., 1862, **23**(4): 494–6, from Proc. roy. soc. Edinb., February, 1862.

Experiments with evaporation of drops of water on hot metal plates, and the electricity accompanying the process, lead to conclusions in harmony with those of Gaugain, 1854.

Tate, Thomas.

Experimental researches on the laws of evaporation and absorption, with a description of a new evaporometer and absorbometer. Phil. mag., 1862, **23**(4): 126–35, 283–9, 494; 1863, **25**(4): 331–42. Synopsis by Cleveland Abbe, 1890.

The rate of evaporation is directly proportional to the difference in temperature indicated by wet- and dry-bulb thermometers and the velocity of the wind, and inversely proportional to the pressure of the atmosphere. From damp porous substances of the same material it is proportional to the extent of the surface exposed without regard to the relative thickness of the substance. From different substances it depends on the roughness or inequalities on their surface, evaporation being greatest from roughest surfaces. From equal surfaces of the same material it is the same in quiet atmosphere whatever the inclination of the surface. A horizontal plate with the damp face upwards evaporates as much as with the damp face downwards. Rate of evaporation is influenced by the elevation above the ground, also by radiation from surrounding bodies,

Describes an atmometer consisting of an open cylindrical tank exposing a water surface of 80 square inches and having a bent tube leading from it supported at an inclination of 1

in 50. A fall of 1/50 inch in the water level in the cylinder will cause the water surface in the tube to move thru the space of 1 inch, thus magnifying the cylinder change by 50. The cylinder is also provided with a displacement gage which may be deprest until the water in the tube is again brought to the original position when the reading on the gage will give the number of cubic inches evaporated.

Wanklyn, J. A.
See Tait, Professor, and J. A. Wanklyn.

1863.

Airy, G. B.
Note on the theory of vapor pressure. Proc. Brit. met. soc., 1863, **1**:365–6.

Discussion of Dalton's laws and theories as attacked by Lamont, 1862.

Bloxham, John Charlton.
On the theory of vapor pressure. Proc. Brit. met. soc., 1863, **1**:362–5.

Further discussion of Dalton's theory of vapor pressure and laws governing it, as attacked by Lamont, 1862.

Cornelius, C. L.
Meteorologie. Halle. 1863. p. 240–4.

Describes atmometers of Mühry, 1861; Babinet, 1848; Saussure, 1789; and the experiments of Marcet, 1853, and Schübler, 1826, 1830, 1831.

Nowak, A. F. P.
Hydrologisch-meteorologische Studie über das Kaspische Meer und die Verdunstung. Sitzber. k. böhm. Ges. d. Wiss. (Prag), 1863, **2** (pt. 2):13–23.

Gives calculations of the inflow and evaporation from the Caspian Sea similar to those made for the Dead Sea (Nowak, 1862). The excess of the inflow in this case is 33 cubic inches more than a German cubic mile.

Nowak, A. F. P.
Das Mittelländische Meer und der Ocean überhaupt gegenüber der Verdunstung. Lotos, 1863, **13**:116–20, 137–44, 155–60, 169–75.

The Mediterranean, like the Caspian and Dead Seas [Nowak, 1862 and 1863, (1)], receives much more water than evaporates from it. It is believed that since the excess can not flow out into the ocean at the surface nor by submarine currents it does so by underground channels.

Symons, G. J.
Evaporation. Brit. Rainf., 1863, (—):12.

Emphasizes the importance of improving the means of measuring evaporation from the earth's surface.

Vivenot, Rudolph von.
Ueber einen neuen Verdunstungsmesser und das bei Verdunstungsbeobachtungen mit demselben einzuschlagende Beobachtungsverfahren. Vienna. 1863. 8vo., p. 36. See also Repert. der Phys., 1866, **1**:203–30, and Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1863, **48**,(pt. 2):110.

A vertical, graduated tube leads from the under surface of the evaporating vessel and its enlarged free end plunges into a stationary vessel of mercury, a suitable mechanism providing for vertical movements of dish and tube. After the evaporating vessel and tube are filled with water to the desired level they are raised until the water surface stands at zero on the graduated tube, and the position of the mercury meniscus is noted by means of an ivory point attached to a scale. Vessel and tube are returned to their original position and the evaporation is allowed to proceed until a reading is desired, when they are once more raised until the mercury stands at the level previously noted. The water surface in the tube now stands somewhat below the zero on the graduated tube, and the reading on this scale indicates the amount lost by evaporation.

1864.

Cantoni, Giovanni.
Osservazioni su la evaporazione e la diffusione dei liquide, e su la imbibizione dei solidi porosi. Rend. r. ist. Lomb., 1864, **1**:183–95.

Dove, Heinrich Wilhelm.
Die Witterungserscheinungen des Nordlichen Deutschlands in Zeitraum von 1858–63. Berlin. 1864. 4to. p. 49–50. Also Preussische Statistik, No. 6. Berlin.

Quotes rates of evaporation for the years 1856–63, obtained by Gube (1864) at Zechen near Guhrau, Silesia. The rates for night, forenoon, afternoon, and the entire day are averaged by months and seasons. The average annual amount for these years was 16.239

inches. To this is added a table of observations by Dippe at Sülze (Beiträgen zur Statistik Mecklenburgs, vol. 2, pt. 2, p. 145), showing the daily mean rate for each month of the years 1856–60. The mean yearly amount at Sülze was 22.58 inches.

Temperature is regarded as very important in determining the evaporation rate. A final table is quoted from Krecke, 1862, containing the evaporation rates for 1862, in millimeters, at the four cities, Helder, Utrecht, Kniesdorp, and Oudorp. The lowest rate is 536 millimeters, for Helder, and the highest 807.6 millimeters, for Kniesdorp.

Grouven, A.

Meteorologische Beobachtungen nebst Beobachtungen über die freiwillige Wasserverdunstung und über die Wärme des Bodens in verschiedenen Tiefen im Jahre 1863 zu Salzmünde (bei Halle). Halle. 1864. 8vo.

Gube, Friedrich.

Die Ergebnisse der Verdunstung und des Niederschlages nach Messungen an neuen, zum Theil registirenden Instrumenten auf der königl. met. Station Zechen bei Guhrau. Mit einem Vorworte von H. Dove. Berlin. 1864. 8vo.

See Dove, 1864.

Prestel, Michael August Friedrich.

Die Aenderung des Wasserstandes der Flüsse und Ströme in der jährlichen Periode, als der jährlichen periodischen Zu- und Abnahme des atmosphärischen Niederschlags und der Verdunstung genau entsprechend an Beobachtungen nachgewiesen. Ber. Deut. Naturf., 1864, **39**:69–77. Also Zeits. Arch. Ver., 1864, **10**:col. 411–23.

It is here maintained that the rainfall, combined with the amount of evaporation, compares more closely with the curve of the river stages than does the rainfall curve alone. In support of this, tables and figures compare rainfall and evaporation at Emden, at Magdeburg on the Elbe, at Küstrin on the Oder, and at Frankfort on the Oder, with diagrams showing the curves of water supply of the respective rivers. Another diagram presents curves of yearly change in water-level of the Rhine at Basel, of the temperature on the St. Gothard, and of the ground-water at the foot of the Alps, showing that the yearly curve of the water-level at the headwaters of the Rhine follows very closely the temperature curves of the higher Alpine regions.

Prestel, Michael August Friedrich.

Ueber den Verdunstungsmesser (Atmidometer). Ber. Deut. Naturf., 1864, **39**:84–6. Also Ill. Zeitg., 1864, **43**:17.

This instrument is a simple constant-level apparatus, consisting of a cylindrical reservoir standing in a shallow, open pan. Water flows out of the reservoir when the level of the water in the pan is low enough to allow air to enter the former. (See Simmonds, 1867, and Prestel, below.)

Prestel, Michael August Friedrich.

Die Regenverhältnisse des Königreiches Hannover, nebst ausführlicher Darstellung aller den atmosphärischen Niederschlag und die Verdunstung betreffenden Grössen welche beim Wasserbau sowie beim rationellen Betriebe der Landwirtschaft in Betracht kommen. Emden. 1864. 4to. 1 ch., 2 pls.

A full description is given of the evaporation gage described in the preceding paper. Observations of evaporation at Zwanenburg, Utrecht, 1743–1841; and at Helder, Utrecht, and Dijon, 1853–62; the latter giving night and day rates with both and averages for each month, are tabulated. Another table brings together the maximum, minimum, and mean at Zwanenburg, Utrecht, Helder, and Dijon, averaging respectively for the year 591.07 mm., 821.55 mm., 601.44 mm., 601.04 mm. The monthly average for these places is added and a discussion of the relation between rainfall and evaporation follows.

Symons, G. J.

Evaporation. Brit. Rainf., 1864, (—).

A table presents rainfall and evaporation at different stations. Attention is drawn to the suspicious variations in the records, probably owing to the different methods of observing.

1865.

Fletcher, Isaac.

Remarks on the rainfall among the Cumberland Mountains, and on evaporation. Brit. Rainf., 1865 (—): 20–2.

Includes a table of monthly evaporation measured by a gage similar to a rain gage.

Hildebrandsson, H. H., and P. G. Rosen.

Några undersökningar om det tryck, vattenången under afdunstning ut öfvar på den omgifvande luften. Öfvers. k. Svenska Vetensk. Akad. Förhandl., 1865, **21**:123–34.

Discussion of Dalton's laws in connection with investigations as to the pressure exerted on the surrounding air by water vapor during evaporation.

Prestel, M. A. F.

Der Verdunstungsmesser (Atmometer) in seiner einfachsten Form. Ber. Deut. Naturf., 1865, (—):101–3. Also Zeits. Oest. Ges. Met., 1866, **1**:192–4. Also translated by Simmonds, 1867.

The same instrument described in the author's paper of 1864.

Rosen, P. G., and H. H. Hildebrandsson.

See Hildebrandsson, 1865.

Tacchini, P.

Atmometro di Vivenot. Bul. met. oss., 1865, **1**(No. 4):2.

Description of Vivenot's (1863) atmometer.

Vaillant.

De l'influence des forêts sur le régime des sources. Les Mondes, 1865, **8**:674–9.

From the results of experiments with the transpiration from the branch of an oak tree it is estimated that a whole tree, about 21 meters high and 2.65 meters in circumference, would transpire, on a day in summer, more than 2,000 kilograms, or 2 cubic meters, of water. He concludes that the trees of a forested country cause it to have less [ground] water than it would possess if planted with cereals.

Vivenot, Rudolph von.

Sulla temperatura, ed umidita dell'aria e sulla evaporazione in Palermo osservazione meteorologiche. Palermo. 1865. Reprinted from La Sicilia.

1866.

Collin, A.

Atmidométrie. Recherches expérimentales sur l'évaporation. Mémoire couronnée par l'Academie des Sciences. Mém. soc. agr. Orléans, 1866. Also, Orléans. 1866. 8vo. Abstract in Compt. rend., 1864, **58**:666. Also, Fortsch. f. Met., 1872, (—):211.

The object of this paper is to show the inaccuracy of a rule, attributed to Halley, according to which the evaporation from a mass of water bears the ratio 5:3 to the amount of rain and snow fallen in the same space and time. The memoir is based on nineteen series of observations, four lasting twenty years, the fifth ten years, the rest only from four to seven years. The observations were from five stations on the Canal of Burgundy, three on the Canal of the Marne, four on the Garonne, seven on the Canal of Nivernais. The evaporators exposed a surface of water more than six square meters in area. The maximum ratio between rainfall and evaporation was found to be 1.46 at Montréjeau and the minimum 0.54 at Gondrexanges. It is concluded that there is no uniform ratio between the two.

Dennis, W. C.

On surface evaporation. Ann. rept. Smithsn. inst., 1866, (—):402.

A letter to Professor Henry describes experiments conducted at Key West, Fla., which show that sea water evaporates slower than fresh water, and that the rate of evaporation of the former decreases as saturation is approached.

Felisch, J.

Was in der Luft vorgeht. Populäre Vorträge über Meteorologie. Berlin. 1866.

Pages 183–94 discuss the laws governing evaporation and its importance to vital phenomena.

Grouven, A.

Ueber das Verhältniss zwischen Wasserverdunstung und Regenfall und dessen agronomische Bedeutung. Allg. Land. Forstw. Zeitg., 1866, (—):16.

Home, D. Milne.

Letter of 2d April, 1866, to Alexander Buchan. Jour. Scot. met. soc., 1864–6, **1**(n.s.):330.

Ramsay, 1884, quotes this author as asserting that the rate of evaporation from bare or partially bare soil is higher than from soil well covered with grass; and higher from sandy loam than from clay.

Markham, C. R.

On the effects of the destruction of forests in the ghauts of India on the water supply. Jour. roy. geog. soc., 1866, **36**:189.

The removal of forests is regarded as undoubtedly increasing evaporation and the rapidity of run-off, as may be seen in the hill districts of India where the floods caused by the monsoon rains are yearly increasing in size and violence.

Schenzl, Guido.

Ueber die Grösse der Verdunstung in Ofen. Zeits. Oest. Ges. Met., 1866, **1**:177–81.

The extreme drought which had prevailed in Hungary led the author to investigate the rate of evaporation from water. Reischauer's (1856), Muhry's (1861), and Vivenot's (1863) atmometers and their studies of evaporation are reviewed. A simple apparatus, ascribed to Vivenot, consists of a pan with a tube and stop-cock below to allow the contents to be drawn off and measured. The water is measured at the beginning and end of the experiment, the difference less the amount of rain fallen in the meantime, is the amount evaporated.

Observations of evaporation, rainfall, and vapor pressure from June, 1863, to June, 1866, are tabulated. He finds no agreement between the rate of evaporation and the mean monthly temperature, since the wind enters as a factor in one case and not in the other. The evaporation for the three years was 2186.97 lines (Fr.), a yearly average of 60.75 inches; the total rainfall was only 566.77 lines (Fr.), yearly average, 15.74 inches. This difference is considered a sufficient explanation for the drying up of the Neusiedler See. From the above results the amount evaporated from the Platten See, 9.5 square miles in area, is estimated at not less than 63,269 million cubic feet for the three years.

Vivenot, Rudolph von.

Beiträge zur Kentniss der klimatischen Evaporationskraft und deren Beziehung zu Temperatur, Feuchtigkeit, Luftströmungen und Niederschlägen. Erlangen. 1866. 8vo.

A report on four independent sets of observations of evaporation made with the instrument described by Vivenot, 1863. It is accompanied by tables and comparative curves of temperature, humidity, direction and velocity of wind, cloudiness, precipitation, etc. The stations were Eltville, on the Rhine, October 8 to December 12, 1861; Lilienfeld, in the Austrian Alps, October 13 to November 4, 1862; Vienna, September 1 to October 12, 1862; and Palermo, Sicily, November 16 to April 10, 1865.

The evaporation observations at Eltville are compared with those at Utrecht and Helder as recorded in 1861 by the Meteorological Institute of the Netherlands. The evaporation at Vienna is compared with observations by Sonklar, eight miles south of Vienna. These curves show no close agreement, the whole curve for the latter place being higher, due probably to a difference in the protection from wind. These comparisons lead to the general conclusion that it is necessary to have similar instruments similarly exposed to get comparable results.

Improvements on the instrument described in the previous article are detailed and tables for correcting the results obtained are added.

1867.

Buchan, Alexander.

A Handy Book of Meteorology. Edinburgh. 1st ed., 1867, p. 82–6; 2d ed., 1868, p. 145–167.

The process of evaporation is discussed in a general way (p. 82–86). Several instruments are described, viz, Mitchell's "evapometer," on the bird-fountain principle; Proctor's evaporometer, similar to Mitchell's but fitted with a diagonal scale; a Leslie atmometer, consisting of a graduated glass tube connected with a hollow, porous ball.

The loss of heat accompanying evaporation is touched upon, and evaporation from different soils is discust in some detail. Evaporation is said to be greater from the surface of loose earth than from a water surface, until the earth is so far dried as to be of a light color. By an experiment it was shown that evaporation from saturated moss greatly exceeds, on the first day, that from water; but on the second day the evaporation from water is in excess, and still more so on the third day, altho the moss is still wet ten inches below the surface. Quotes Home, 1866. It is pointed out that evaporation depends on the extent of the evaporating surface in contact with the air; but that as evaporation from soil proceeds, the rate is modified by the facility with which water is drawn by capillarity from the interior to the evaporating surface.

Cantoni, Giovanni.

Evaporimetre costrutto nell' officina "Tecnomasio italiano" di Milano. Met. ital. sup., 1867, (—):38–9.

A glass cylindrical evaporating vessel is fitted with a small adjustable cone, whose point indicates the standard level of the water. The whole is protected from rain by a metal shelter.

Haughton, Samuel.

On the evaporation of a water surface at St. Helena. (1864.) Proc. roy. Irish acad., 1867, **9**:126–47.

Experiments carried on for two years with similar evaporators, one fully exposed, the other set in a large tub of water, showed a rate nearly 50 per cent higher from the former than from the latter.

Henry, D. F.

Table X, showing the evaporation and humidity for different winds at Milwaukee, for 1862–4. Also Tables Y and Z, showing temperature, humidity, and evaporation at Milwaukee, 1862–4. Rpt. Chf. Eng., 1867:599, 785–95.

From these tables it is concluded that evaporation is but slightly affected by the direction or velocity of the wind, that it is almost inversely proportional to the increase in humidity and directly proportional to the temperature.

Lyell, Sir Charles.
Principles of Geology. London. 1867. 10th ed. p. 286, 497.

Calls attention to the fact that dry winds evaporated snow very rapidly. The evaporation from some lakes is said to be equal to the quantity flowing in, notably in the Caspian (see Nowak, 1863). Lyell regards evaporation as a competent cause of oceanic currents, hence such currents might in some cases "afford valuable evidence as to the distribution of aqueous vapor."
Quoted by Ramsay, 1884.

Ragona, Domenico.
Sulle osservazioni eseguite nel R. Osservatorio di Modena. Met. ital. sup., 1867, (—):13–17. Also noticed in Zeits. Oest. Ges. Met., 1867, 2:380.

Evaporation measured by Vivenot's (1863) atmometer, as improved by the author, leads to the formula $E = 12.711\text{mm.} + 0.02623\text{ mm. } t - 0.14869\text{ mm. } U$, in which t = the temperature of the air °C., and U = the relative humidity. The evaporation rate from a freely exposed surface was three or four times greater than from a Vivenot atmometer, the annual amount from the former being 3,463 millimeters; that from the latter, 940 millimeters. The rainfall for the same period was 567 millimeters. A table compares results from several different instruments. The rate of evaporation from several salt solutions is compared with that from pure water (see Hann, 1868).

Raulin, F. V.
De l'évaporation à Toulouse et dans le sud-ouest de la France. Rev. soc. sav., 1867, 1:155–64.

It is pointed out that "observations of evaporation should complement those of rain for the solution of a large number of questions relating to agriculture, to public works, and to industry." Tables present the evaporation at Poitiers (1789–91), Niort (1802–20), Saint Maurice and le Girard (1777–83), La Rochelle (1781–4), Bordeaux (1775–84, 1853–5, 1854–64), Cadillac (1856–64), Langon (1858–64), Agen (1857–64). Toulouse (1785–87, 1816–64), Rieux (1783–91?), and Montrejeau (1857–64). A comparison of evaporation and rainfall at Orange shows an excess of the former in the case of six instruments, and the opposite in the case of four others. Gasparin is referred to as stating that in Italy evaporation is almost double the rainfall, while at Rome and Lisbon it is almost triple. Recommends observations with vessels surrounded by large bodies of water.

Simmonds, G. Harvey.
Evaporation from rain-gages. Proc. Brit. met. soc., 1867, 3:326–8, 426–8.

The error due to evaporation is reported as small if the readings are made only once a month.

Simmonds, G. H.
The evaporation gage (atmometer) in its simplest form. Proc. Brit. met. soc., 1867, 3:337–9.

Translation of "Der Verdunstungsmesser (atmometer) in seiner einfachsten Form," by M. A. F. Prestel, 1865.
See Prestel, 1864, 2d title, for a description of this instrument.

Symons, G. J.
Evaporation from rain gages. Proc. Brit. met. soc., 1867, 3:408–11.

Comments on Simmonds', 1867, paper of the same title.

Symons, G. J.
Review of Saussure's Essais sur l'hygrométrie. Symons' met. mag., 1867, 2:66–8, 88–90.

See Saussure, 1783.

Symons, G. J.
Evaporators and evaporation. Brit. rainf., 1867, (—):9–10.

Evaporation is declared to be "the most desperate branch of the desperate science of meteorology," owing to the great number and variation in the factors to be considered. For instance, the evaporation from soil involves the nature of the soil and subsoil, the inclination of the ground, the presence or absence of vegetation, the nature of the vegetation, the aspect of the ground, almost every variation in climate, temperature, wind, rain, humidity, sunshine and cloud, the physical characteristics of the district, proximity to the sea, altitude, etc.

He suggests an elaborate plan for comparing evaporation from water, grass growing on clay, grass on sand, grass, corn and roots on the soil of the district, the soil of the district with no vegetation, peat, etc.

Tacchini, P.
Sull' evaporazione osservata in Palermo nel 1865 e 1866. Bul. met. oss., 1867, 3:1–10, 17–19. Translated in Ann. rpt. Smithsn. inst. 1870:457–66.

Evaporation is compared from two atmometers, the Gasparin and the Vivenot, from May, 1865, to December, 1866. Accompanying the table of daily observations with the Vivenot are observations of the monthly average temperature, humidity, and velocity of wind, whence is derived the equation:

$$E = 0.20675\,t - 0.01517\,H + 0.11006\,F,$$

t being the temperature [of the air] in °C., H the humidity in 100ths of saturation, F the hourly velocity of the wind in kilometers. The observed and calculated values of monthly evaporation and their differences are tabulated, also the mean temperature and the mean quantity of rain. A table of seasonal and annual evaporation is added. The annual evaporation was $2\frac{1}{4}$ times the rainfall.

The actual results from the Gasparin apparatus are corrected by comparison with the Vivenot. A table shows the monthly sine of the sun's altitude, the degree of cloudiness, force of the wind, the daily and monthly evaporation from the Gasparin, the monthly rate from the Vivenot, and the difference. A second equation is derived:

$$E' = 0.20675\,t - 0.06517\,H + 0.2642\,F - 0.0651\,V + 2.9227 \sin h,$$

in which V is the cloudiness exprest in 100ths of the sky obscured, $\sin h$ the sine of the meridian altitude of the sun, and the rest as above. A table of observed and calculated results is followed by a table of mean temperature, mean humidity, $\sin h$, daily evaporation, and total evaporation for the seasons and year. The total evaporation for the year was nearly three times the rainfall and equal to one and one-third that shown in the shade by the Vivenot. Other comparative studies are described, showing the relation between the day and night rates, and the seasonal differences.

Tacchini, P.

Esperienze sui vasi evaporatori. Bul. met. oss., 1867, 3:53–5.

Evaporation from a Gasparin atmometer was compared with that from five glass tubes of different diameters, from June 25 to July 4, 1867. The Gasparin has a surface of 10 square decimeters; the diameters of the tubes were: tube 1 = 28 mm., tube 2 = 20 mm., tube 3 = 10 mm., tube 4 = 8 mm., and tube 5 = 7 mm. The respective amounts evaporated were 1.00, 1.96, 2.13, 1.73, 1.47, 1.28 millimeters.

Tacchini, P.

Sui diametro o larghezza dei vasi evaporatori, e della differenza fra l'evaporazione del giorne e della notte. Bul. met. oss., 1867, 3:65–8. Also in Gior. sci. nat., 1867, 3:65–8.

A comparison of the rates of evaporation from five tubes of different diameters, allowing them to evaporate without refilling after each observation. The table gives the distance of the water surface from the top and the amount evaporated. The rate diminishes as the distance from the top increases and as the diameter of the tube diminishes. A coefficient is deduced by which the normal evaporation for each tube may be determined, supposing the refilling to have taken place. Ratios between evaporation from a Gasparin atmometer and five tubes show little variance at night compared with similar ratios for the daytime, when the ratio is highest between the Gasparin and the tubes of the largest diameter, smallest with those of the smallest diameter. The reason for this result is believed to be the fact that the tubes of large diameter had a higher temperature than those of smaller diameters, even higher than that of the Gasparin.

1868.

Buchan, Alexander.

A handy book of meteorology. Edinburgh. 1868. 2d ed. p. 148–54.

Ebermayer, E.

Aufgabe und Bedeutung der in Bayern zu forstlichen Zwecken errichteten meteorologischen Stationen. Zeits. Oest. Ges. Met., 1868, 3:97–108.

Emphasizes the importance of having at all meteorological stations, comparative observations of evaporation of water in forests and in open places.

Hann, Julius.

Verdunstung des Meerwassers. Zeits. Oest. Ges. Met., 1868, 3:505.

Compares the results of the observations by Chapmann, 1855, and Ragona, 1867, on the evaporation from salt and fresh water. Chapmann found salt water evaporated only 0.54 as much as fresh water. Ragona in his first experiment found a similar result; but in his second it appeared that the relation varied so much with the temperature and humidity of the air that sometimes the evaporation from salt water exceeded that from fresh water. Neither of these observers gives the strength of the salt solution used.

Henry, D. F.

Tables of evaporation from observations by the Survey of the Northern and Northwestern Lakes. Tables showing comparative readings of evaporators in lake and river, open air and water. Rpt. Chf. Eng., 1868:976–80.

Tables of evaporation and temperature at Milwaukee, Wis., for November, 1861; May–October, 1862; April–October, 1863; April–July, 1864. The mean daily temperature in degrees divided by the mean daily evaporation in inches yields a rather constant ratio between these two factors from which a table is compiled showing the mean daily evaporation in decimals of an inch for each month at Superior, Wis., from 1862–67; at Ontonagon, Mich., from 1861–65; at Milwaukee, Wis., from 1861–67; at Tawas, Mich., from 1861–65; at Thunder Bay Island, Mich., from 1861–65; at Detroit, Mich., from 1861–64; at Monroe, Mich.,

from 1863–67; and at Cleveland, Ohio., from 1861–67. The evaporators used in the experiments were fully exposed to the sun. A few experiments with one evaporator in the usual position and one floated in the water, showed that the lake evaporation is probably not over 64 per cent of that shown by the land instruments. A table compiled according to this correction shows the daily evaporation, the daily amount of rain, and mean temperature at the several lake-survey meteorological stations for the different years. These figures show a somewhat regular relation between the evaporation and the rainfall, the mean being the same for all latitudes. The relation between the mean temperature and the evaporation is still more regular and decreases with the latitude. Another table shows the mean daily evaporation, amount of rain, temperature, latitude and longitude at the several stations, from which is calculated: the daily evaporation from Lake Superior = 0.0436 inch, from Lake Michigan = 0.0617 inch, from Lake Huron = 0.0672 inch, and from Lake Ontario = 0.0642 inch.

Jahn, G. A.

Handbuch der Witterungskunde. Leipsic. 1868. 3d ed.

See Jahn, 1855.

Lamont, Johann von.

Ein neuer Verdunstungsmesser. Repert. der Phys., 1868, 4:197–200. Also Zeits. Oest. Ges. Met., 1869, 4:81–6.

The evaporating cylinder is connected with a reservoir in which slides a piston which can be raised or lowered so as to fill or empty the evaporating dish. The piston is first raised until the water stands at the opening into the evaporating cylinder, and a reading is taken of the water level in the reservoir by means of a scale attached thereto. The piston is then prest back and the dish fills. At the end of the period the piston is raised until the water again stands in the opening, and a reading on the scale is again taken, the difference between the two readings gives the amount of water evaporated. The author recommends the use of this instrument for determining humidity also. In his experiments he finds a greater evaporation from smaller evaporating dishes, but in a constant relation.

Ragona, D.

Osservazioni sulla evaporazione eseguite nel R. Osservatoria di Modena, 1867. Mem. reg. accad. sci. Modena, 1868, 9:186. Also, Modena. 1868. 4to. p. 39.

Symons, G. J.

Evaporation. Brit. Rainf., 1868:(—).

Table of monthly evaporation at Strathfield Turgiss, Hants. Casella's so-called "evaporator" (?), was used with rather unsatisfactory results.

Vogel, K. August.

Ueber den Einfluss des Bodens auf den Wassergehalt der Luft. Sitzber. k. bayer. Akad. Wiss. math. phys. Kl., 1868, 2:497–500.

Reference is made to previous experiments which showed that evaporation is greater from soil without vegetation than from soil with, and that the kind of soil is also an important factor. Further experiments determined (by absorption in sulfuric acid) the amount of water actually present in the air above fallow ground and above that covered with vegetation, showing a higher absolute humidity over the latter.

1869.

Dufour, Louis.

Note sur la différence entre la pluie et l'évaporation observée [pendant 1869] à Lausanne. Bul. soc. vaud. sci. nat., 1869, 10:233–48. Translated in Zeits. Oest. Ges. Met., 1872, 7:113–23. Also quoted and abstracted in Arch. sci. phys. et nat., 1870, 37:243–51. Also abstracted in Quart. jour. roy. met. soc., 1873, 1:112.

Emphasis is here laid on the importance to meteorology of the determination of both rainfall and evaporation. The siccimeter invented by the author measures directly the difference between these two elements. It consists of an open vessel set tightly into the upper portion of a deeper vessel. The former is provided with a vertical tube passing thru its bottom and extending nearly to its rim. The upper vessel is filled with water to the top of the tube and is then allowed to evaporate and collect rain in the open air. If rain fills the upper vessel above the level of the tube water will run over into the lower vessel, and thus any excess of rainfall or evaporation may be determined.

Conditions influencing evaporation are discust and a curve presents the variation in the level of water exposed in the above manner. There is also a résumé of observations from 1865–1868. The approximate mean annual excess of rain is 288 millimeters, the mean annual evaporation is 669 millimeters, the rainfall is 957 millimeters.

Field, Rogers.

Notes on evaporation from a water surface. Being short abstracts of three papers in the Annales des ponts et chaussées. And a note on experiments by Mr. Greaves, at Lea Bridge. Brit. Rainf., 1869 (—): 157–62.

See Ruinet, 1860; Tarbé, 1852; and Vallés, 1850.

Field, Rogers, and G. J. Symons.

On the determination of the real amount of evaporation from the surface of water. Rpt. Brit. assoc. adv. sci., 1869, **39**: 25–6. Brit. Rainf., 1869 (—): 151–76 (App.). Also Van Nostrand's engin. mag., 1870, **2**:143–7. Abstract in Symons's met. mag., 1869, **4**: 132.

Describes the hook-gage devised by Field and used for measuring the height of water in a tank or reservoir. If the point of the hook is ever so slightly raised above the surface it raises a small cone of water with it which is at once rendered visible by the distortion of the reflection. If, on the other hand, the point is deprest below the water, it carries the water down with it, and forms a depression which also causes distortion of the reflection. It is, therefore, only necessary to adjust the hook so that there shall be no distortion, and the point will then be precisely level with the surface of the water.

Tabulates the rates of evaporation from Casella, Symons, and Phillips evaporators during part of July and August, 1869, at Camden Square, London, together with the temperature of the water in each instrument, also computes the evaporation from the indications of the hygrometer.

Fletcher, Isaac.

Remarks on the rainfall among the Cumberland Mountains, for the years 1865–7, and on evaporation. Brit. Rainf., 1869, (—): 36–9.

From a table of the monthly evaporation at Tarnbank, Cumberland, as measured from a gage similar to a rain gage, it is concluded that the rainfall and evaporation for this region are nearly equal, that is, between 46 and 47 inches.

Henry, D. F.

Tables of evaporation from observations by the Survey of the Northern and Northwestern Lakes. Tables showing comparative readings of evaporators in lake and river, open air and water. Rpt. Chf. Eng., 1869: 602–5. (Continued from 1868).

The differences between simultaneous readings of an evaporator at the meteorological station and one placed in the St. Clair River, from August 10 to September 14, 1868, are tabulated. The total land evaporation was 4.039 inches, that in the river was 1.997 inches. Similar observations on the Niagara and St. Lawrence rivers gave similar results. The amount of rainfall over the lake and its water-shed, and the ratio between rainfall and outflow in 1868 on Lakes Huron, Superior, Michigan, Erie, and Ontario are tabulated; also the amount of rainfall minus the evaporation from the lake surface, and the ratio between evaporation and outflow at the several stations for each lake in 1868.

Hildebrandsson, H. H.

Historisk redögorelse för de vigtigaste åstigerna on vätskors afdunstning. Tidskr. math. fys., 1869, **2**: 26–37.

Hosaeus, A.

Die Wasserverdunstung einiger Kulturpflanzen. Ann. Landw., 1869, **53**: 259–71.

Chiefly a study of transpiration from different crops, with some consideration of evaporation from soil.

Lamont, J. von.

Verschiedene Einrichtungen des Verdunstungsmessers. Münch. Stern. Wochenbl., 1869: 234–5. Also Repert. der Phys., 1870, **6**: 113–6.

Different methods of measuring evaporation are described. One form of instrument consists of two reservoirs, one closed the other open, connected at their bases by a graduated tube containing an air bubble. As water evaporates from the open dish, the air bubble changes position, and the difference in readings on the scale gives the amount of evaporation.

Lamont, J. von.

Bemerkungen über das Messen der Wasserverdunstung in freier Luft. Zeits. Oest. Ges. Met., 1869, **4**:241–6.

Gives the details of further experiments comparing evaporation from water in dishes of different sizes. Repeats the table given in Lamont, 1868. Advises experiments to compare evaporation in different exposures. Suggests the use of the atmometer as a psychrometer, as it determines the average humidity for any given period, an advantage over the usual method which only determines it for momentary periods.

Marié-Davy, H.

Atmidomètre à vase poreux de Babinet. Nouv. mét., 1869, **2**:253–4.

This atmometer consists of a porous vessel, similar to those used in ordinary electric batteries, closed by a stopper bearing a glass tube of small bore which leads to a copper cylinder, furnished laterally with a vertical glass tube graduated in millimeters. The porous vessel is filled with water and remains filled by capillarity, in spite of the evaporation which operates at its surface, and although the level of the water in the reservoir is lower than the evaporating surface. The section of the supply reservoir is only 0.0379 of the evaporating surface; this ratio can be varied at will. An extreme sensibility is claimed for this instrument, together with the possibility of following from hour to hour the pro-

gress of evaporation and of obtaining at a given hour and day, the effect upon it of temperature, the state of the sky, the movement and humidity of the air, etc. It is regarded as an apparatus suitable for experimentation rather than an instrument able to remain for a long time comparable to itself. Unless it is supplied with distilled water, calcareous salts dissolved in the water gradually incrust the pores and destroy the permeability of the clay, which may be restored by washing with a very weak solution of acetic acid. Gives a table showing the hourly rate for July 7-8. When the pores are free evaporation from this surface is found to be almost as rapid as that from a free water surface, taking into account the temperature of the evaporating water. Evaporation is proportional to the difference between the actual tension of water vapor in the air, and the vapor tension of saturated air at the temperature of the evaporating surface. The temperature of the porous surface is lower than that of the surface of freely exposed water, because in the latter case the evaporating surface is warmed by diffusion from the main body of water, while in the former diffusion is very slow. In one afternoon the porous vessel evaporated 1.584 mm. at a mean temperature of 27.6° C., while an ordinary atmometer lost 2.844 mm. at a mean temperature of 33.5° C.

Risler, Eugène.

Sur l'évaporation du sol. Arch. sci. phys. et nat., 1869, **36**:27–33. Also summarized in Proc. inst. civ. engin., 1876, **45**:56.

Experiments were made at Calève, near Nyon, Switzerland, with drain gages 1.2 meters deep containing a compact and impervious subsoil. The average annual rainfall, 1867–8, was 41 inches, 70 per cent of which evaporated, and 30 per cent percolated into the ground.

Symons, G. J. and Rogers Field.

See Rogers Field.

Symons, G. J.

Evaporation. Brit. Rainf., 1869, (—).

Tables compare results of evaporation observations with various atmometers, which are described. They generally consisted of vessels, more or less protected from overheating, for determining the amount lost from a free water surface. Those of Beverly, Buist, Casella, Dalton, Dines, Greaves, Howard, J. F. Miller, S. H. Miller, Mitchell (bird-fountain device), Proctor, Sharple, Steinmetz, are of this form.

1870.

Ansted, D. T.

Physical Geography. 1870. 4th ed. p. 285–6. Abstract in Ramsay, 1884.

Refers to the enormous force consumed in the evaporation of water from the ocean. Estimates total annual rainfall of the earth at not less than 200 millions of millions of tons. Assuming the evaporation to be equal to the rainfall, an average of about 7,000 pounds of water evaporate every minute from each square mile of ocean surface. "The conversion of this into vapor, conveyance thru the air, and recondensation means a force equivalent to the lifting of very much more than 1,500,000 millions of millions of pounds of water one foot high per minute of time during the whole period." This does not include the large evaporation from the land surfaces of the earth.

Dines, George.

Evaporation. Symons's met. mag., 1870, **5**:70–2. Review in Brit. rainf., 1889, (—): 24–5.

Compares the rates of evaporation from five evaporators of different sizes, the largest 1½ feet in diameter, and finds the largest lost less than ⅔ of the amount lost by the smallest. The temperature of the water in the largest evaporator varied from 32° to 77° in April, while the river temperatures varied from 39° to 60.3°; in June the temperature of the former varied from 33° to 84°, but the river varied only from 46° to 66.8°. The influence of temperature upon the rate of evaporation is shown by the following observation: "In a room of which the temperature was 62°, water of that temperature evaporated at the rate of 0.003 inches per hour (about 26 inches in a year), and water at 88° evaporated at the rate of 0.015 inches per hour (about 131 inches per year)."

Dines, G[eorge].

On evaporation and evaporation gages, with some remarks on the formation of dew. (1870.) Short abstract and note in Nature, 1870, **3**:79; Proc. Brit. met. soc., 1871, **5**:199–213.

Experiments in evaporation from water at temperatures below 176° F. showed that evaporation goes on until the temperature of the water, falling lower than that of the air, approaches the dew-point; that condensation occurs at temperatures of 32° and higher until the dew-point is again approached. The dew-point thus indicates very closely the line of demarcation between evaporation and condensation. Dalton's formula, $Dx=E$ (where D is the vapor pressure in inches of mercury at the temperature of the water minus that at the dew-point, and x is a constant determined by experiment), is considered approximately correct when water temperature and dew-point are far apart, but uncertain when these temperatures closely approach each other. Experiments showing the influence of heat are described, together with others in which the depth of the water below the edge of the vessel exerted considerable influence on the amount of evaporation. Evaporation from sea water amounted to 4½ per cent less than that from rain water, and this difference increased with increasing concentration.

Dufour, Louis.

Observations siccimétriques à Lausanne. Bul. soc. vaud. sci. nat., 1870, **10**:555–6. Also Les mondes, 1873, **31**:570–2. Also Bul. int. obs. Paris, June 17–18, 1873; Mar. 26–27, 1875. Also conclusions in Arch. sci. phys. et nat., 1870, **37**:245; 1875, **52**:241–3; 1875, **53**: 129–31.

The siccimeter described in Dufour, 1869, showed almost equal rainfall (855 millimeters) and evaporation (860 millimeters) in 1869.

Dufour, Charles, and F. A. Forel.

Recherches sur la condensation de la vapeur aqueuse de l'air au contact de la glace et sur l'évaporation. Bul. soc. vaud. sci. nat., 1870, **10**:621–84; Les mondes, 1871, **26**:129–36, 183–9, 242–51. Abstracted in Arch. sci. phys. et nat., 1871, **40**:239–73; Ann. chim. et phys., 1871, **25**:80–1; Naturforscher, 1872, **5**:59–60.

A study of the hygrometric action of glaciers on the atmosphere and vice versa. Conclusions: (1) With air having a vapor pressure less than 4.6 millimeters condensation or evaporation will take place at the surface of the glacier according to the relative pressures of the water vapor of the air and that of the ice. These actions tend to counterbalance each other. (2) Condensation takes place whenever the atmospheric vapor pressure is above 4.6 millimeters. (3) The total result of condensation and evaporation must be very much in favor of the latter. (4) The glacier by these counteracting influences tends to restore the pressure of the water vapor in the air to 4.6 millimeters, except in the case of condensation at temperatures lower than zero. (5) Since, in the latitudes studied, the average hygrometric capacity of the air is above 4.6 millimeters pressure, the glacier exercises a very powerful drying influence on the atmosphere. (6) Condensation tends to prevent the extension of the glacier owing to the heat which it frees.

Forel, F. A., and Charles Dufour.

See Dufour, Charles, and F. A. Forel.

Hajech, Camillo.

Ricerche sperimentali sull' evaporazione di un lago. Rend. r. ist. lomb., 1870, **3** (2):785–90.

Compares the evaporation from three similar instruments exposing a free water surface 1 decimeter square, one floating on the surface of the lake, the second on land near the the lake, and the third on land, but farther from the lake. The results obtained from August 31 to October 7, show: (1) The maximum mean hourly evaporation occurred from all three on the same days, viz, September 16 and 17. (2) The quantities evaporated from the three in the daytime, were to each other as 100:140:149; when the sky was cloudy as 100:130:130; after sunset as 100:156:225; and for the entire day as 100:150:180.

Henry, D. Farrand.

Tables of evaporation from observations of the survey of the northern and northwestern lakes. Tables showing comparative readings of evaporators in lake and river, open air, and water. Rpt. Chief Eng., 1870: 570–3.

A table of results shows the difference between simultaneous readings of the evaporator at the meteorological station and one placed in the water at Youngstown, N. Y., from June 11, to September 23, 1869. Evaporation was greatest on land, the ratio between the two being 0.558. Thermometric observations of the air, of the surface of the water in the evaporators, and in the lake showed no definite ratio between the water temperature and the rate of evaporation.

Lamont, Johann von.

Langsam Verdunstung des Wassers in engen Röhren. Münch. Stern. Wochenbl., 1870, (—):263.

Moscati, Pietro.

Lettera al Signor de Saussure con la descrizione d'un atmidometro e d'altre macchine altinenti alla meteorologia. n. p. 1870. 4to.

Pfaff, A. B. I. F.

Ueber den Betrag der Verdunstung einer Eiche während der ganzen Vegetationsperiode. Sitzber. k. bayer. Akad. Wiss. math. phys. Kl., 1870, **1**:27–45. Also Ber. Phys. Med. Soc., 1870, **2**. Abstracted in Zeits. Oest. Ges. Met., 1871, **6**:10–2. Also Naturforscher, 1871, **4**:85–7. Also Gaea, 1871, **7**:247–9.

See Hann, 1871, for the results of Pfaff's experiments.

Risler, E.

Evaporation du sol et des plantes. Arch. sci. phys. et nat., 1870, **37**:214–28. Also Zeits. f. Naturw., 1872, **6**:117–9.

The monthly evaporation during 1869 from soil of different depths is calculated from the difference between the amount of rainfall and the amount artificially drained off, the latter

amount being at least partially corrected by a periodic determination of the moisture content of the soil.

Somerville, Mary.
Physical Geography. London. 1870. 6th ed. p. 223.

The fact that the sea water of the Southern Hemisphere contains more salt than that of the Northern is suppo-ed to be due to the greater evaporation in the former, caused by the southeast trade winds blowing over a greater expanse of water than the northeast. It is computed that 186,240 cubic miles of water are evaporated (annually ?) from the surface of the globe, chiefly from intratropical seas. This would cause a lowering of the sea level by 5 feet annually. The equilibrium in these seas, thus disturbed, is restored by means of currents.

Strachan, Robert.
Lamont's vaporimeter. Symons's met. mag., 1870, **5**:73–4.

For a description of this instrument see Lamont, 1869.

Symons, G. J.
On evaporation. Brit. rainf., 1870, (—):175–83, (app.).

Experiments were carried on at Strathfield Turgiss with different evaporators, including Howard's, Miller's (a tin vessel with overflow, felt protected), Miller's sand evaporator, a glazed earthenware jar set in the ground, a glass cylinder, Proctor's, Sharples', Fletcher's, etc., of various sizes, etc. Observations on the temperature of the water in each showed that vessels which absorb heat most readily allow much more evaporation than others. A table gives the amount of evaporation for 1870 at various localities in Great Britain, with a description of the methods employed. The large tank used at Strathfield Turgiss is especially notable.

Vogel, K. A.
Versuche über die Wasserverdunstung auf besätem und unbesätem Boden. Abh. k. Bayer. Akad. Wis. math. phys. Kl., 1870, **10**: 321–55.

From experiments similar to those of his previous paper (see 1868) it is concluded that evaporation is greater from limestone soil than from clay soil; greater from unplanted soil, both clay and limestone, than from planted; but greater from peat soil when planted than when unplanted. Results obtained with the "atmidometer, (see Vogel and Reischauer, 1856), showed differences similar to those observed in the absolute humidity of the air over the different soils.

1871.

Buchan, Alexander.
Introductory Text-book of Meteorology. Edinburgh. 1871.

See Buchan, 1868, for an account similar to that on p. 88–91 of this work.

Casella, L.
Catalogue of Scientific Instruments. London. 1871. 8vo. p. 24.

Two metal vessels are described for measuring evaporation from a free water surface, also a recording instrument, in which the changes in the level of a water surface are communicated to a recording cylinder by means of a float and pulley. Doctor Babington's "atmidometer" for measuring evaporation from water, ice, or snow, is mentioned on page 21, but not described.

Dines, G.
Reply to "On Evaporation of Water," by Henry Hudson in Symons's met. mag., 1871. Symons's met. mag., 1871, **6**:190–2.

The following statements, made in a previous article, 1870, are reaffirmed: "When the air is saturated with moisture and the water is of the same temperature as the air, neither evaporation nor condensation can take place." "Except as it affects the dew-point, it is a matter of little consequence whether the air is saturated or not; other circumstances being the same, it is the difference between the temperature of the water and that of the dew-point which determines the amount both of evaporation and condensation." The author's experiments with the wet- and dry-bulb thermometers in obtaining the dew-point lead him to think that they can never give more than an approximation to the moisture in the atmosphere Hudson's conclusion that water may evaporate at a temperature several degrees below the dew-point when the air is nearly saturated, is refuted.

Dufour, Louis.
Sur le siccimètre. Ann. chim. et phys., 1871, **23**:78–80.

The siccimeter is designed to measure the difference between evaporation and rainfall (see Dufour, 1869.)

Hann, Julius.
Ueber den Einfluss der Bäume auf die Feuchtigkeit der Atmosphäre und des Bodens. Zeits. Oest. Ges. Met., 1871, **6**:10–12.

The experiments of Unger, 1861, Vaillant, 1865, and Pfaff, 1870, in attempting to calculate the total evaporation from a large tree by means of the observed amount evaporated from a single branch are here reviewed. According to Pfaff an oak tree having 700,000 leaves, each with a surface of 2,325 sq. mm., would evaporate from May 18 to October 24, 120,000 kg. This means an evaporation from the surface of the ground which the tree covered, of 5.39 meters while the rainfall for that area is only 0.65 meter. According to Hann, however, this does not show the amount that would evaporate under natural conditions.

In the woods the temperature is low, the humidity is high, and the air movement very sluggish. At night evaporation ceases and dew is formed, and in the daytime only a very small portion of the leaves at the top are subjected to the conditions under which the branches were placed in Pfaff's experiments.

Hann, Julius.

Verdunstung auf den Azoren und auf Madeira. Zeits. Oest. Ges. Met., 1871, 6 : 411.

Table of monthly percentage of clouds, evaporation in millimeters, wind velocity, etc., from December [1854?] to January, 1857.

Hoffmann, H.

Untersuchungen über die Bilanz der Verdunstung und des Niederschlages. Zeits. Oest. Ges. Met., 1871, 6 : 177–81. Versuchsstat. Org., 1872, 15 : 95–104. Abstract in Naturforscher, 1871, 4 : 324–5. English abstract by Robert Warington, in Jour. Chem. Soc., 1872, 10 : 1038–9.

Reviews the work of Unger, Schübler, Laws, Hartig, Saussure, Pfaff, etc. Unger's observations that a water surface evaporates about three times as much as a plant of the same surface, and that a forest in leaf evaporates much more than a water surface of the same area as the ground covered by the forest, are contradicted by Hartig who showed that evaporation from a water surface or from bare soil is greater than from a forest. Schübler's results are quoted, showing daily evaporation to be, from a water surface, 1 line; from turf, 2 to 3 lines; from bare soil, 0.60 lines; and from forest, 0.25 lines.

The author's own experiments, at the Botanical Garden in Seissen, Germany, with evaporation from a water surface in a glass vessel, showed a total amount lost by evaporation from May to September for 3 years (1855–8) to be 55.86 inches, with a rainfall of 45.68 inches. The author believes, however, that soil would not lose moisture at the same rate as the water surface in the experiment, the upper layers of the soil protecting the lower. He considers it important, therefore, in a dry climate to keep the soil covered with moss or dead leaves to prevent its drying out.

Hudson, Henry.

On evaporation of water. Symons's met. mag., 1871, 6 : 166–8.

Challenges the conclusions drawn by Dines, 1870, concerning the point at which water will cease to evaporate and condensation will begin, and apparently concludes that water will evaporate when at a temperature several degrees below the dew-point.

The statements in this paper are vague and were later refuted by Dines, 1871.

Mann, R. J.

On evaporation, rainfall, and elastic force of vapor. Proc. Brit. met. soc., 1871, 5 : 285–97. Also London. 1871. 8vo.

From experiments with evaporation of water at different temperatures, the following formula is derived: The depth of evaporation in inches per hour $= 1.5 \sqrt{T + \left\{1 - \left(\frac{e}{e_1}\right)\right\} D}$ where $T =$ the absolute temperature (°F.) of the surface of the water (that is, 461° + the ordinary scale); $e =$ the vapor pressure in inches in air; $e_1 =$ the vapor pressure at the temperature of the evaporating water, and $D =$ the density in pounds avoirdupois per cubic foot of the vapor at the temperature of the water. Altering the formula so as to use Glaisher's hygrometric tables only, a complicated expression is deduced, together with a simpler one which is sufficiently approximate. The latter is as follows: $E = 0.04 \times$ (the vapor pressure at the temperature of the water)—(the vapor pressure at the temperature of the air), i. e., $E = 0.04\,(e_1 - e)$. It is concluded that evaporation depends almost wholly on the three factors, the area of the water surface, the temperature of the water at its surface, and the vapor pressure in the air above the water. The retarding influence of the height of the rim of the vessel above the evaporating surface is also shown. Experiments with evaporation from sea water resulted in a rate of evaporation 5 per cent smaller than that from fresh water. The evaporation from the eastern side of the North Atlantic is calculated at 58.56 inches annually.

Risler, E.

Évaporation du sol et des plantes. Arch. sci. phys. et nat., 1871, 42 : 220–63. Zeits. f. Naturw., 1872, 6 : 117–19.

Continuation of the author's paper of 1870.

1872.

Abbot, Francis.

Results of five years' meteorological observations for Hobart Town, with which are incorporated the results of twenty-five years' observations previously published by the Royal Society of Tasmania, and completing a period of thirty years. Tasmania. 1872. 8 p.

A pluviometer and an evaporator were employed for these observations. The latter is a dish 5 inches in diameter, having an overflow pipe a little below the rim. A table shows the total excess of evaporation over rainfall at Hobart Town for the five years 1866–70 was 95.58 inches. The average annual evaporation is 42.18 inches and the rainfall 23.06 inches.

Buys-Ballot, C. H. D.

Ueber die Verdunstung von einer Wasseroberfläche. Zeits. Oest. Ges. Met., 1872, 7:223–5.

Refers to the work of Schulze, Vogel, Vivenot, Field, and Symons. Emphasizes the need of having a large evaporating surface, also the need of protecting the walls of the vessel either by sinking it in the ground or placing it in a larger reservoir of water. A table of results obtained by A. Erlich Sterk with two instruments, one small and unprotected, the other a large cylinder placed in a larger reservoir, shows a difference of 250.5 millimeters in a year. The difference is greater in the daytime than at night, 209 millimeters for the former and only 41.7 millimeters for the latter. The author obtained only 70 millimeters difference in similar experiments, but his smaller instrument was somewhat shaded.

Buys-Ballot, C. H. D.

Suggestions on a uniform system of meteorological observations. Utrecht. 1872. 56 p.

Advises uniformity of apparatus for measuring evaporation.

Buys-Ballot, C. H. D.

Indications de deux évaporimètres, l'un exposé selon la manière habituelle, l'autre nageant dans l'eau libre, ou dans un très-grand réservoir. Bul. int. de l'obs. de Paris, 4 Juin, 1872.

Fritsch, Karl.

Bemerkungen über die Beobachtungen mit dem Verdunstungsmesser. Zeits. Oest. Ges. Met., 1872, 7:124–7.

Emphasizes the important influence which the exposure of the atmometer may exert on the rate of evaporation. Summarizes the results of observations at Prague from 1833–37, at Vienna from 1868–70, by Vivenot in 1866–7, and Schenzl in 1863–5.

Karsten, Gustav.

Luftfeuchtigkeit, Niederschläge, Verdunstung, in den Herzogthümen. Beiträge zur Landeskunde der Herzogthümer Schleswig und Holstein. Reihe II, Heft II. Berlin. 1872. 4to.

Lemoine, G.

On the relation of forests to hydrology. Paper read to the British Association, Brighton meeting, 1872. Abstract in Symons's met. mag., 1872, 6:161.

Describes experiments by Chapman on evaporation in South Africa. Two jars were sunk in the ground, one protected by a bush and the other in cleared ground. The rate from the latter jar was more than double that from the former. The evaporation during the hot, windy, dry season of the district, is believed to exceed by 384,000 gallons, the amount that would have been evaporated if the bush and grass had not been burned off.

Moureaux, Th.

Note sur l'atmismomètre de M. Piche. Bul. int. de l'obs. de Paris, 2, 3, Juin, 1872.

Pfaff, Fr.

Versuche über Verdunstung. Zeits. Deut. Geolog. Ges., 1872, 24: 401–9.

The evaporation at Erlangen from pure water and from a 2.5 per cent salt solution for a year resulted in totals of 750 and 659 millimeters, respectively, or as 100 to 87. Observations of evaporation from pure water for the two years previous, and of the rainfall, which in all three years surpassed the amount evaporated from salt water, led to the conclusion that salt could not be obtained here by natural evaporation from a bay separated from the ocean.

Piche, Albert.

Note sur l'atmismomètre, instrument destinée à mesurer l'évaporation. Bul. assoc. sci. de France, 1872, 10:166–7; also Sci. pour tous, 1872, 17:226; Ann. sci. ind., 1872, 16:58–60; and Zeits. Oest. Ges. Met., 1873, 8:270–1.

This instrument consists of a vertical graduated glass tube, 1 centimeter in diameter 23 to 30 centimeters long, closed above and provided with a ring by which it can be suspended. The tube is filled with water, a circular piece of moist blotting paper with an area of 8 square centimeters, is clamped over the open end, the whole inverted and the water allowed to evaporate from the surface of the paper. The differences in the height of the water in the tube give the amounts evaporated. A minute opening in the center of the paper allows air to rise and take the place of the evaporated water.

Prettner, Johann.

Ueber einen einfachen Verdunstungsmesser. Zeits. Oest. Ges. Met., 1872, 7:319.

Describes a metal vessel in which to expose a surface of water for evaporation. A fixt needle point marks the standard level.

Ragona, D.

Sulla evaporazione dell' aqua salea. In Lettere meteorologiche al conte G. Vimercati. Rev. sci. ind., 1872. Also Florence. 1872. 8vo.

Symons, J. G.

On evaporation. Brit. rainf., 1872, (—):11–15.

Refers to a self-recording atmometer devised by Symons and Field. A table shows the rate of evaporation in different localities, measured by various methods. Evaporation was generally 10 to 15 per cent less in 1871 than in 1870. A table of monthly evaporation in the neighborhood of Manchester is appended.

Volpicelli, Paolo.

Sulla evaporazione dei liquidi, favorita della elettricità. Att. r. accad. Lincei, 1872, **25**:63–6.

Provenzali, in the Rev. sci. ind. de 1871, p. 119, stated that, "The action of static electricity on the evaporation of liquids is a fact that has generally past unnoticed, neither do I know that any one has ever closely examined it." Volpicelli shows that this statement is ungrounded, since many eminent investigators have attempted to solve this problem. He describes the researches of Cavallo, Hermbstadt (See Hermstädt, 1801), Van Marum, Schübler, Muncke, Nollet, and Beccaria. With the exception of Van Marum and Muncke, who obtained negative results, all the experiments together with his own which he describes have shown that electrification of water increases the evaporation from it.

1873.

Buys-Ballot, C. H. D.

A sequel to the suggestions on a uniform system of meteorological observations. Utrecht. 1873.

See Buys-Ballot, 1872, 1st title.

Decharme, C.

Effets frigorifiques produits par la capillarité jointe à l'évaporation; évaporation du sulfure de carbone sur du papier spongieux. (Extrait). Compt. rend., 1873, **77**:998, 1157.

A porous paper dipping into carbon bisulphide and supported in the air, is described as a very simple hygroscope. The drier the air, the less the cooling, the less rapid the evaporation, and the less the deposit of crystals.

Delesse, A. and A. de Lapparent.

Influence des forêts sur la quantité de pluie et sur l'évaporation. Rev. geol., 1873, **11**. Also Bul. assoc. sci. de France, 1873, **12**:190–1.

Dufour, Louis.

Observations siccimètriques à Lausanne. Bul. soc. vaud. sci. nat., 1873, **11**:151–62, 329–32; 1873, **12**:162–9.

Continuation of Dufour, 1870.

Ebermayer, E.

Die physikalischen Einwirkung des Waldes auf Luft und Boden, und seine klimatologische und hygienische Bedeutung. Aschaffenburg. 1873. Abstracts in Zeits. Oest. Ges. Met., 1873, **8**:253–5; and in Fortsch. f. Met., 1873: 140–5.

Evaporation from a free water surface in a forest is found to be about 64 per cent less than in the open, both summer and winter. The loss from the surface of a saturated soil, 6 inches deep, is three or four times less in the forest than in the open. Evaporation from two soils, one covered with straw, the other bare, is compared and found that the litter contributes as much to the holding of soil moisture as the forest itself. The amount evaporated in the open during six summer months was 409 mm., while from bare forest soil it was 158 mm., and from forest soil covered with litter only 62 mm. These observations illustrate the influence on river supply exerted by the presence of forests.

Lapparent, A. de, and A. Delesse.

See Delesse, 1873.

Leslie, Alexander.

On rainfall and evaporation in its relation to water supply. Trans. roy. Scot. soc. arts, 1873, **8**:243–61.

A comparison of the annual rainfall with the run-off in the district of Reiroch Burn shows a loss of 12.72 in., as due to evaporation.

Marié-Davy, H.

Évaporation du sol et des plantes. Bul. mens. obs. phys. cent., 1873, **2**:111–21, 155–62, 189–94.

It is stated that the rate of evaporation depends on the rate of movement of the air as measured by the anemometer, and on the difference between the elastic force of the vapor of the evaporating water and that of the vapor contained in the air, as measured by the psychrometer. Evaporation from plants and soils is determined by daily weighings of potted plants and pots of soil without plants. A table compares the evaporation from a Piche instrument with that from dishes of bare soil, the latter exhibiting from one to two times as great a rate as the former. Soil temperatures are deduced from the evaporation rate. Daily evaporation from growing grain (June, 1873), is compared with that from bare soil and from water with very varying results. Further experiments are elaborated along the same lines.

Marié-Davy, H.

Radiations solaires et évaporation des plantes. Bul. mens. obs. phys. cent., 1873, **2**:173–9.

In a study of the effect of color, as shown by observations of Déhérain on evaporation from leaves of maize in sunlight transmitted thru colored solutions, the highest rate of evaporation was produced under orange light, with red, blue, and green following in the order named.

Miller, S. H.

Evaporation. Brit. rainf., 1873, (—):204–8 (app).

The author attempts to discover "some law of relation between the amount of water evaporated and the temperature of evaporation or that of the dew-point," but does not obtain "such results as would give constants for evaporation." New evaporometers for use with soil are described.

Mott, A. J.

Periodicity of rainfall. Letter to the Editor. Nature, 1873, **7**:161.

General discussion of the relations between rainfall, evaporation, and wind. Solar spots, by causing temperature inequalities and the formation of barometric differences, are said to give rise to special areas of evaporation.

Stefan, J.

Versuche über die Verdampfung. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1873, **68** (pt. 2):385–428. Abstracts in Zeits. Oest. Ges. Met., 1882, **17**:63–8; and Phil. mag., 1873, **46**:483–4.

From experiments with evaporation of ether from narrow tubes the following laws are deduced: (1) The velocity of evaporation of a liquid from a tube is inversely proportional to the distance of the surface of the liquid from the open end of the tube. This holds closely when the distance slightly exceeds 10 millimeters. (2) The rate of evaporation is independent o the diameter of the tube (for diameters between 0.3 and 8.0 millimeters). (3) The rate o evaporation increases with the temperature so far as this is accompanied by an increase in the vapor pressure of the liquid. When p = vapor pressure of saturated air at the temperature of the observation, and P=the atmospheric pressure under which the liquid evaporates, then the rate of evaporation is proportional to $\log \frac{P}{P-p}$. If the vapor pressure of the liquid equals that of the atmosphere this expression becomes infinity, and the liquid boils.

Also describes experiments in which the open end of an otherwise closed tube is dipt in ether. Bubbles are emitted from the tube and when the tube contains air the times in which successive equal numbers of bubbles form are at first proportional to the odd numbers. If the immersed tube contains hydrogen instead of air, the same number of bubbles form in one-fourth the time, whence he concludes that evaporation proceeds in hydrogen four times as rapidly as in air.

Stevenson, Peter.

Description of the atmometro-hygrometer. Trans. roy. Scot. soc. arts, 1873, **8**:160–3.

Two thermometers were inverted, the bulb of one being inclosed in one of Leslie's (1813) porous bulbs, the latter being kept wet by a cotton wick. The wick was fed from a glass tube reservoir with a graduated scale. From the indications of this instrument and by the use of Glaisher's hygrometric tables, the dew-point and relative humidity could be determined, and successive observations of the level of the water in the graduated tube gave the rate of evaporation.

Symons, G. J.

(Bibliography of evaporation.) Symons's met. mag., 1873, **8**:196.

The editor gives a short bibliography of the literature of evaporation.

Symons, G. J.

On evaporation. Brit. rainf., 1873 (—):203–4 (append.).

A table is presented of monthly evaporation at various points in Great Britain, as measured by different instruments. The results vary between annual totals of 7.96 inches and 40.26 inches.

A small metal dish, allowing evaporation from a free surface of water, is described, in which the level of the water is measured by a brass scale divided to hundredths of an inch. The temperatures of the water in this vessel, of the air, and of a running stream were compared on three different dates; the water in the evaporator was always at a higher temperature than that of the air or of the running stream.

1874.

Bateman, J. F.

Evaporation of snow. Proc. inst. civ. engin., 1874, **39**:34.

A discussion of Binnie, 1874, on the Nagpur Waterworks. Rapid evaporation of snow during the prevalence of an east wind was observed even at temperatures below the freezing point.

Binnie, Alexander R.

The Nagpur Waterworks; with observations on the rainfall, the flow from the ground, and evaporation at Nagpur, and the fluctuation of rainfall in India, and in other places, with discussion; edited by John Forrest. Proc. inst. civ. engin., 1874, **39**:1–32. Also quoted by Blanford, 1877.

The amount of water used by the city was calculated and subtracted from the total loss from the city storage reservoir. The difference between the two was taken as the amount lost by evaporation. By this method the total depth evaporated from October 10, 1872, to June 1, 1873, was 4 feet, giving a daily average of one-fifth inch. Of the total loss from the reservoir during the dry season 54 per cent was evaporated.

Dufour, Louis.

Observations siccimétriques à Lausanne. Bul. soc. vaud. sci. nat., 1874, **13**:371–5.

The average annual evaporation, as shown by the author's siccimeter (described by Dufour, 1869), for the seven years, 1865–73, is 738 millimeters; that for 1874 is 702.5 millimeters.

Hough, G. W.

Self-registering evaporometer and rain-gage. Nature, 1874, **9**:250. Noticed in Zeits. Oest. Ges. Met., 1874, **9**:93.

An evaporating vessel, 2 feet square and 1 foot deep, was supported on levers held in equilibrium by a small spring, so that any change in weight, due either to rainfall or evaporation was indicated on a scale. A continuous record was obtained upon a revolving drum by means of an electro-magnet and clock-work.

Marriott, William.

Tables for facilitating the determination of the dew-point from observations of the dry- and wet-bulb thermometers. London. 1874. 8vo.

Osnaghi, F.

Modification des Messverfahrens und autographische Einrichtung bei Verdunstungs Apparaten. Zeits. Oest. Ges. Met., 1874, **9**:54–6.

Describes weighing and registering apparatus of the type of Wild's spring balance (see Wild, 1874), and also possessing the advantage of recording during the winter.

Scott, Robert H.

Report of the Proceedings of the Meteorological Congress at Vienna. 1874. (p. 53–5, translation of the report of the Committee on Evaporation by Ebermayer.)

The committee adopted Leslie's term "atmometer" for an evaporation gage as possessing "the merits of seniority and a correct classical derivation." All atmometers were divided into two groups, those weighing the losses by a delicate balance, and those measuring the changes in volume. Theoretically the former gives the most accurate results, but requires much attention and very delicate balances; therefore, for general meteorological observations, those of the second class are recommended.

The requirements in a good atmometer of the second class are: (a) The evaporating dish should not be too small, and for comparative results the surfaces should be identical in all instruments. (b) The water level must be kept constant. (c) Reading should be accurate to millimeters in depth. Small instruments for scientific purposes should be sheltered with the thermometer and hygrometer; but for practical purposes larger instruments should be used and should be exposed to the sun and wind and compared with the raingage. Various instruments of both types are recommended.

Wild, H.

Ueber einen einfachen Verdunstungsmesser für Sommer und Winter. Bul. acad. imp. sci., 1874, **19**: col. 440–6. Also Repert. f. Met., 1874, **10**:273–8. Also Acad. sci. mét., **9**:51–61. Abstract in Chem. Centbl., 1874,(—): 465–6.

Attention is called to the fact that the rate of evaporation can not be determined by measuring the loss of volume when the temperature is below 0° C. The weighing method, e. g., as embodied in the instrument described (see Shaw, 1877), is the only one then possible. Wild gives a table of the mean daily evaporation, temperature, relative humidity, and wind velocity at the Central Physical Observatory at St. Petersburg during 1872–3. The mean daily evaporation varied from 0.12 millimeters in February to 2.83 millimeters in June, the average for the year being 0.98 millimeters, or a yearly total of about 350 millimeters. Contemporaneous experiments with an ordinary atmometer, exposing a surface of 1 sq. m., gave 1.4 times higher evaporation during the summer than did the Wild instrument.

1875.

Brown, John Croumbie.

Hydrology of South Africa; or details of the former hydrographic condition of the Cape of Good Hope, and of the causes of its present aridity, with suggestions of appropriate remedies for this aridity. London. 1875.

The phenomenon of evaporation is discussed on p. 158. On p. 194 et seq. are described experiments which were made by Mathieu, one of the directors of the Forestry School at Nancy, France, and published by the French government in the Atlas météorologique de l'observatoire impérial for 1867. The rate of evaporation from a vessel of water placed in the ground and surrounded by trees was found to be about one-fifth of that from a similar vessel in the open. Experiments in the neighborhood of Capetown, S. Africa, showed the retarding influence upon evaporation produced by the protection from wind afforded by nearby vegetation.

Decharme, C.

Note sur l'évaporomètre au sulphure de carbon. Bul. assoc. sci. de France, 1875, **17**: 55–8. Also Bul. int. de l'obs. de Paris, 23 Oct., 1875.

The idea suggested in a paper by Decharme, 1873, is here developed. As the Piche instrument, with water, could not be used in time of frost, carbon bisulphide was placed in the tube instead of water. The formation, during the evaporation of this substance, of a thick border of frost on the paper was regarded as a factor whose relation with other meteorological phenomena might furnish useful indications. The curve of the rate of evaporation of carbon bisulphide was shown to be the inverse of that of water. Under average circumstances, causes favoring evaporation from water and retarding that from carbon bisulphide are dryness, heat, and increase of vapor tension, but increased velocity of the wind acts in a similar manner upon both. Thus curious anomalies are produced in the correlative curves.

Mohn, H.

Grundzüge der Meteorologie. Berlin. 1875. Reviewed in Fortschr. f. Met., 1875.

A general definition of evaporation on p. 77–8.

Wollny, Ewald.

Der Verdunstungsmesser von Johann Greiner. Zeits. Oest. Ges. Met., 1875, **10**:255–6.

An evaporating dish, with vertical sides, and 113 millimeters in diameter, has a tube with a stop-cock leading from the center of its base. One hundred cubic centimeters of water are poured into the evaporating dish and left to evaporate for a certain time. The stop-cock is then opened and the remaining water drained into a graduated tube to measure the amount lost by evaporation.

1876.

Greaves, Charles.

On evaporation and percolation. Proc. inst. civ. engin., 1876, **45**: 19–47, 56–62. Also London, 1876. 8vo. Also abstract in Van Nostrand's engin. mag., 1877, **16**:48-52. Summarized by Fanning, 1889.

Careful experiments were made to determine the maximum and minimum, total and periodic quantities of (1) rain falling, (2) rain percolating thru soil and re-evaporated from it, (3) rain percolating thru sand and re-evaporated from it, (4) water evaporated from a water surface, and (5) their correlation. The gages used were constructed on the principle of Dalton's gage [see Dalton, 1802, (2)]. The most notable results obtained from these records were: (1) The great magnitude of percolation thru sand at all times; (2) the usual small amount of percolation thru ordinary soil; (3) the large evaporation from, and the entire absence of percolation thru ordinary soil in warm summer weather; (4) that in winter evaporation from soil exceeds that from a water surface, while in summer the evaporation from a water surface is the greater; (5) the shallow depth of the layer of soil below which water may be considered safe from loss by evaporation; (6) the great variations in the annual percolation. The maximum yearly evaporation from a water surface was 27 inches and the minimum, 17 inches. An appendix with 26 tables of results from 1860–73 is given on p. 56–62.

The discussion was continued by John Evans and Doctor Gilbert with accounts of their work along the same lines. Results of various observers are summarized, notably those of Ebermayer in Bavaria in 1873, and those obtained at Rothamsted, near Harpenden, Herts, 1870–5.

Humber, William.

A comprehensive treatise on the water supply of cities and towns. London. 1876. Imp. 4to.

Contains a chapter on rainfall and evaporation.

Morgenstern, Ludwig.

Ueber ein neues Atmometer. Repert. f. Met., 1876, **12**: 520–38.

(See below, Symons, 1876, for description.)

Murray, Digby.

Ocean currents. Nature, 1876, **15**: 76–7. Reviewed by Ramsay, 1884.

Discusses the cause of ocean currents, but does not decide whether the greater amount of evaporation occurs in the northern or the southern hemisphere.

Stelling, Ed.

Beobachtungen über Verdunstung in Tiflis von A. Noeschel bearbeitet von E. Stelling. St. Petersburg. 1876. 4to. Also Repert. f. Met., 1876, **5**: No. 9, 9 p. Abstract in Zeit. Oest. Ges. Met., 1877, **12**: 315–6.

Evaporation in the sun and shade was observed from April to November, together with rainfall, temperature, humidity, cloudiness, and wind velocity. Daily observations during June and July, 1872, showed the rate from the atmometer exposed in the sun averaged 2.2 times that from the shaded one. Observations from May to September, 1875, gave the corresponding ratio as 2.6. The apparatus was built by A. Noeschel, and consisted of two communicating vessels, one 25.4 centimeters in diameter and 19 centimeters deep; the other, 5 centimeters in diameter and 19 centimeters deep. A float in the second indicated changes in level against a scale graduated to tenths of a millimeter, on the glass tube in which it was free to move.

Symons, G. J.

Account of the Loan Exhibition at South Kensington. Symons's met. mag., 1876, **11**: 156–9.

Describes forms of evaporometers designed by Lamont, Osnaghi (see 1874), Skertchley, Ebermayer, and Morgenstern. Skertchley's apparatus consists of two vessels, one set within the other, the inner holding the evaporating water while the outer one is covered and acts as a reservoir. Over the whole is a glass vessel which receives the water vapor. Ebermayer's is a simple apparatus for determining the amount of evaporation from different kinds of soil.

Morgenstern's evaporometer presents a saturated surface of siliceous sand, the loss by evaporation from this surface being replaced by water from a burette forming a Mariotte's bottle. A tube entering from below supplies air as the water is withdrawn. The evaporating vessel is enveloped by some heat-insulating material.

1877.

Baumgartner, Georg.

Ueber den Einfluss der Temperatur auf die Verdampfungsgeschwindigkeit von Flüssigkeiten. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1877, **75** (pt. 2): 679–88.

A mathematical discussion of diffusion coefficients after Stefan, 1873.

Blanford, H. F.

Meteorology of India. Indian Meteorologist's Vade-Mecum, pt. II. Calcutta. 1877. p. 16, 55, 100.

Regnault's formula for latent heat of evaporation is quoted as follows: $Q = 1091.7 + 0.305 (t-32)$ units of heat, where Q is the total quantity of heat required to raise water from 32°F. and to evaporate it at t°F. A general discussion of evaporation and its effects is followed by tables of observations in India by Laidlay, 1845, and by T. G. Taylor at the Madras Observatory between 1830–43. Taylor observed the evaporation from a free water surface in a cylindrical copper vessel; the evaporation being increased by the action of the sun on the metal sides of the vessel, but, on the other hand, the surface was somewhat protected from the wind by the walls of the vessel. The mean daily evaporation for the thirteen years was 0.35 inch. Ludlow, 1846, found 0.25 inch per day, Binnie, 1874, in the very dry climate of Nagpur, found 0.198 inch from a large reservoir, and Jackson, 1885, found 0.125 inch per day from a tank.

From these results Blanford assumes 0.10 inch as the daily evaporation from the seas around India and estimates the total evaporation per square mile as 232,320 cubic feet, or a weight of 14,475,000 pounds, requiring, at 80°F., the absorption of 7,975,725,000 units of heat.

Cantoni, Giovanni.

Su l'evaporazione dell'acqua e delle terre, e sugli evaporimetri. Met. ital. sup., 1877 (pt. 1): 56–61.

Results of experiments made from May 31 to June 8, upon the rate of evaporation from water, saturated coarse sand, and saturated finer sand, confirm the results obtained by Marcet, 1853, along the same lines. Similar results were obtained with another series of experiments from June 12 to July 9. The temperature was found to be much higher in the lower layers of sand than in the upper layers while it was but little higher near the bottom of the water than above. The temperature of the sand was uniformly lower than that of the water. Experiments showed a higher rate of evaporation from soils with vegetation than from those without. The results of a comparison of the rates of evaporation from different instruments emphasize the necessity of perfect uniformity in form, exposure, and management of atmometers in comparative studies. Other observations showed lower temperatures and less rapid evaporation in forested than in unforested regions.

Frisiani, P.

Sulla dipendenza dell' evaporazione dell' area e della figura della superficie liquida evaporante. Rend. r. ist. lomb., 1877, **10**: 537–50.

Experiments with evaporation of water (1) from vessels of similar form and different area, (2) from vessels of equal area and different perimeter, (3) from vessels in which the surface of the liquid was at different levels, indicate that other factors besides the area of the surface complicate the phenomenon, and that, therefore, the relative indications furnished by different instruments are not comparable.

Johnen, Adolf.

Forstlich-meteorologische Beiträge. Centbl. Agr. Chem., 1877, Heft VI, 325–27. Abstract in Forsch. Geb. Agr. Phys., 1878, **1**:257–8.

A study of the relation of rainfall to evaporation at different stations with forest covers of different ages, disclosed the fact that the difference (rainfall–evaporation) increases as the forest becomes older.

Léger, A.

Hygrométrie et évaporométrie. Communication présentée à la société des sciences industriales de Lyon dans la séance du 27 Juin, 1877. Lyon. 1877. 8vo. 22 p.

Marié-Davy, H.

Evaporomètre et autres appareils enregistreurs de l'Observatoire de Montsouris. Jour. de phys., Paris, 1877, **6**:201–3.

The recording "evaporometer" here described consists of a weighing apparatus connected with a recording drum. Another form consists of a dish filled with water, in which floats a hollow ball of zinc, which by means of a rack on its stem operates the pinion of a pointer moving over a graduated dial. Snow and ice interfere with the operation of this instrument, but do not invalidate the self-registering balance first described.

Milani, Gustavo.

Corso elementaire fisica e meteorologia. Milan. 1877.

Statement of laws of evaporation and a discussion of the methods of measuring its rate on p. 698 and 1351.

Miller, S. H.

On a self-registering atmometer. Quart. jour. roy. met. soc., 1877, **3**:9–17.

Describes an elaborate arrangement in which the evaporating vessel, exposing a free water surface, is surrounded by a closed compartment divided horizontally into two sections. The upper section contains water, and is planned to maintain the evaporating surface at a constant level, the lower receives any overflow due to rainfall. The amount evaporated is determined by weighing the whole apparatus. Evaporation from this atmometer closely agrees with that from a tank 6 feet square.

Ragona, D.

Evaporimetro registratore. Ann. soc. met. ital., 1877, **1**:321–4.

——————

Remarkable results of evaporation and rainfall. Sci. Amer., 1877, **36**:257.

A discussion of the general relation between evaporation and rainfall. The evaporation from the aqueous surface of the earth must be much greater than that from the land. Therefore practically only the evaporation from the aqueous surface or three-fourths of the whole surface of the earth provides the rainfall for the whole, and the evaporation from a given surface of land must surpass the amount of rainfall for that area. Seas which have no outlet, as the Great Salt Lake, Utah, and the Caspian, must become more and more salt as the inflowing water continues to evaporate.

Shaw, William Napier.

Report on evaporimeters. Comparison of observations of the rate of evaporation of water as given by different instruments. Quarterly Weather Report of the Meteorological Office for 1877. London. 1885. p. (35)–(42).

Observations were made with evaporometers designed by Wild, Lamont, De la Rue, and Piche. The Wild instrument exposes a free water surface in a shallow cylindrical dish 17.8 millimeters in diameter supported on the short arm of a lever balance. The longer arm, acting as a counterpoise, ends in a pointer which moves over a graduated quadrantal arc, indicating the loss of weight due to evaporation. Lamont's instrument (see Lamont, 1868), with a diameter of about 3 inches, possesses two uncertainties in its manipulation: (1) The last portion of water drains but slowly from the pan when the piston is raised, so that one may obtain readings differing by several scale divisions according to the time that the pan is allowed to drain. (2) The annular space between the piston and cylinder supports by capillarity a variable amount of water, which introduces an error in the readings. A dust film on the surface also interferes with the action of evaporation.

In the De la Rue form the water evaporates from a surface of moistened parchment paper stretched over a shallow drum of 5 inches diameter supplied with water from a reservoir giving about 6 inches head and fitted with a constant level device. A graduated glass cylinder shows the amount lost by evaporation. It is intermittent in its action, as the water in the graduated vessel is replaced only by the ascending of large bubbles of air, and at times the slightest jar causes a rapid rise of bubbles, so that, with judicious shaking, any reading within wide limits may be obtained. The reading is sensibly affected by changes in temperature and pressure.

With the Piche instrument (see Piche, 1872) there are three difficulties: (1) A certain difference of pressure between the air inside and outside the tube is required to force the bubbles through the paper, and this may not be constant. (2) The condensation of water on the sides of the tube on the water surface. (3) Considerable variations in temperature and barometric pressure affect this instrument as they do De la Rue's. Factors were determined for the reduction of the indications of the other instruments to those of the Wild. A table shows the percentage of difference between the corrected results. The Wild instrument seems to have become less and less sensitive as time elapsed, probably due to the formation of the dust-film which remained undisturbed on the evaporating surface. The following condensed table shows that evaporation decreases as the evaporating area increases:

	Wild.	De la Rue.	Lamont.	Piche.
Area (square centimeters)	245.8	125.6	49.2	11.1
Total evaporation (millimeters)	26.52	32.35	43.57	54.7
Evaporation per square centimeter	0.108	0.258	0.886	4.928

Weilenmann, A.

Die Verdunstung des Wassers. Schweiz. met. Beob., 1877, **12**: 268, 368. Reprinted Zürich. 1877.

Derives the following formula for calculating the daily evaporation, h, from the temperature, psychrometer difference, and wind velocity:

$$h=\mu_1\left(\Sigma\frac{m}{a+\lambda}+\gamma\cdot\Sigma\frac{mv}{a+\lambda}\right),$$

where μ_1, γ, and λ are constants to be determined from observation, v is the wind velocity at the surface of the water in kilometers per hour, a is the change in the vapor tension of saturated air for 1°C., m is the saturation deficit in grams per cubic meter, and Σ is the factor necessary to reduce the evaporation from observed time to a desired time. The results calculated by this formula closely agree with those actually observed.

Weilenmann, A.

Berechnung der Grösse der Verdunstung aus den meteorologischen Factoren. Zeits. Oest. Ges. Met., 1877, **12**:368.

Quantities calculated by the formula of the preceding paper closely agree with quantities observed at Vienna, September, 1874, to January, 1877, with a weighing apparatus, and at Montsouris from July, 1873, to April, 1875, with a Piche instrument.

Zeithammer, L. M.

Ueber die Wasserverdunstung des Bodens. Oest. landw. Wochenbl., 1877, (–):512.

1878.

Bartoli, A.

Sulla evaporazione: nota. Florence. 1878. 8vo. 10 p. Also Riv. sci. ind.

Bebber, W. J. van.

Die allgemeinen Niederschlagsverhältnisse mit besonderen Berücksichtigung Deutschlands. Forsch. Geb. Agr. Phys., 1878, **1**:341–76.

In connection with a discussion of humidity the author illustrates and describes the Piche evaporometer.

Boussingault, Joseph.

Études sur les fonctions physiques des feuilles: transpiration, absorption de la vapeur aqueuse, de l'eau, des matières salines. Ann. chim. et phys., 1878, **13**:289–393.

Experiments with transpiration from leaves showed great differences between sun and shade. Calculates that an acre of beets loses 8,000 to 9,000 kilograms of water in twenty-four hours.

Cantoni, Giovanni.

Sugli evaporimetri. Mem. met. ital., 1878 (pt. 4): 67–71. Also Rome. 1879.

Reviews experiments by Tacchini, Ragona, Stefan, Bartoli, and Frisiani. They show, in general, the great influence of the design and exposure of the atmometer. Cantoni's experiments, compared the Piche, the Vivenot-Ragona, and the modified Piche (see Cantoni, 1879). He concludes that the different specific heats of the liquids and the different conductivities of the containing vessels were the chief causes for the observed differences in evaporation.

Johnson, S. W.

Studies on the relations of soils to water. Ann. rpt. Conn. agr. exp. sta. for 1877. New Haven. 1878. p. 76–81.

Leslie, Alexander.

See following entry.

Leslie, John and Alexander Leslie.

Notes on evaporation at Glencorse. Jour. Scot. met. soc., 1878, **5**: 108–9.

Observed evaporation of water in an iron vessel 6 feet in diameter. Tables of monthly evaporation near the filters at Glencorse [Edinburgh] reservoir during 1857–76 show the yearly total varying between 14.70 inches in 1868 and 9.19 inches in 1866.

Lorenz, J. R.

Entwurf eines Programmes für forstlich-meteorologische Beobachtungen in Oesterreich. Mitt. forst. Versuchsw. Oest., 1878, **2**:73–91. Abstract in Forsch. Geb. Agr. Phys., 1878, **1**: 248–57.

Considers observations of evaporation a necessary part of observational meteorology.

Marié-Davy, H.

Rapport au Ministre sur les travaux de l'observatoire de Montsouris pendant l'année 1876–7. Ann. de l'obs. de Montsouris, 1878, (–): 187, 323–7, 413–15, 456–7.

A general discussion of the evaporation of water. Describes the Piche atmometer, and the Delahaye, which consists of a protected tank with a float and self-recording instruments. Diagrams of evaporation and rainfall are reproduced.

Mascart, E.

Influence de l'électricité sur l'évaporation. Compt. rend., 1878, **86**: 575–6. Also Les Mondes, 1878, **45**: 461–3. Abstract in Proc. inst. civ. engin., 1878, **53**: 390.

The electric phenomena accompanying evaporation, observed by Volta and Pouillet, from which they concluded that evaporation is the source of atmospheric electricity, have been explained on the ground that the electric phenomena were due to the nature of the walls of the vessel, and not to the evaporation itself. Mascart's experiments show, however, that electricity accelerates evaporation.

Miller, S. H.

Prize essay on Evaporation. Utrecht. 1878. 4to. 27 p. Also Brit. rainf., 1890, (–): 17–29.

According to Symons, Miller gives average results of three years' experiments at Wisbech with evaporation from water, and from soil with and without vegetation, in the following table:

Evaporating surface.	Annual evaporation.	Relative amounts.
	Inches.	*Per cent.*
Water	17.02	100
Peat	13.62	80
Sand	14.03	83
Clay	13.58	80
Garden mould	15.12	89
Garden mould (in shade)	6.27	37
Long grass	48.16	283
Short grass	23.50	138
Red clover	53.44	314
White clover	31.15	183

Modena, Reale Osservatorio.

Osservazioni sulla evaporazione. Ann. soc. met. ital., 1878, **1**.

Ragona, D.

Evaporazione all' aria libera e al sole. Ann. soc. met. ital., 1878, **1**:115–18.

Ragona, D.

Importance des observations relatives à l'évaporation. Compt. rend., 1878, **7**:491-2.

In the general expression for the amount of evaporation, which takes into account relative humidity, temperature, and velocity of the wind, the author found at Modena coefficients similar to those obtained by Tacchini at Palermo. The rate of evaporation in the sun was found to be nearly three times that in the shade. From the mean daily evaporation in sheltered shade the total annual evaporation in the open air and sun is computed at 2.611 meters. In discussing the paper Tacchini calls attention to the fact that measurements of evaporation for meteorological purposes are quite different from those made for agricultural purposes, the results with small tube atmometers used by meteorologists having no application to agriculture, where nothing less than a surface 1 meter square should be used.

Thomson, C. Wyville.

Geography. Opening address to Geographical Section of the British Association by the President. Nature, 1878, **18**:449. Abstract by Ramsay, 1884.

This paper includes a discussion of the influence of evaporation on ocean currents. The constant inward current through the Straits of Gibraltar is said to be necessary to keep up the supply of water in the Mediterranean, where evaporation is greatly in excess of the precipitation.

Todd, Charles.

Meteorological observations, made at the Adelaide Observatory, during 1876 and 1877. Adelaide. 1878. 246 p. Reviewed in Symons's met. mag., 1879, **14**:72–3.

The atmometer used in these experiments was similar to the large tank at Strathfield Turgiss. The average annual evaporation for the six years, 1870–5, was 67.309 inches, and the average annual rainfall was but 24.479 inches.

Vogel, K. A.

Ueber Wasserverdunstung von verschiedenen Vegetations-decken. Sitzber. k. bayer. Akad. Wiss., math. phys. Kl., 1878, **8**:539–45.

The number of grams of water in a cubic meter of atmosphere over different soils with different plant covers, was determined by means of a hygrometer. The results of earlier (1868) experiments are corroborated in the following points: (1) The evaporation from soil with vegetation is considerably greater than from soil without. (2) The kind of plant has a decided influence on the amount of water evaporated.

Wheeler, W. H.

Arterial drainage and the storage of water. Jour. roy. agr. soc., 1878, **14**:1–60.

Includes a discussion of the relations between evaporation and rainfall as bearing on the storage of water.

1879.

Alexandre, F.

Note relative à la mesure de l'évaporation de l'eau. Congrès de mét., Expos. univ. int. de Paris, 1878, Compt. rend. sténog., no. 20: 207–16. 1879. Also Paris. 1881. 12 p. 8vo.

Describes experiments carried on at Angoulême with a rectangular sheet iron evaporator 1.5 meters by 1 meter by 40 centimeters, with cement bottom and an outlet. The difficulty of reading, owing to small oscillations of the water surface, was obviated by floating in the large tank a smaller basin, 225 millimeters in diameter, the level of the water in which was observed to tenths of a millimeter by means of a sheet iron float which actuated a pointer. Corrections were made for the influence of heat on the walls of the apparatus and on the water. Tables of other meteorological observations accompany those of evaporation. The maximum daily evaporation for the summer, 9 millimeters, occurred on August 1 with the maximum temperature of the air, 34° C., and of the water, 31° C.

Beaudrimont, A.

Evaporation de l'eau sous l'influence de la radiation solaire ayant traversé des verres colorés. Compt. rend., 1879, **89**: 41–3; and Monit. sci., 1879, **21**: 1076–80. Abstract in Ciel et Terre, 1881, **1**: 404–5.

Observations of the variation in rate of evaporation of water under the influence of solar radiation through different colored glass. Yellow and colorless glass produced the most evaporation, red the least. (See Marié-Davy, 1873, 2d title.)

Borius.

De l'identité des résultats fournis au Sénégal par l'observation de l'évaporomètre de Piche et du papier ozonométrique de Jame (de Sedan). Congrès de mét., Expos. univ. int. de Paris, 1878, Comp. rend. sténog., no. 20: 187–8. 1879.

Curves of the evaporation as measured by the Piche evaporometer, and of the ozone of the atmosphere as indicated by ozone-paper, when drawn with zero points in opposition continued almost exactly identical for thirty months. In spite of detected uncertainties in the ozonometric method the author considers it very interesting to ascertain that both physical and chemical methods furnish identical results. He considers that the value of the Piche instrument as a means of research remains to be determined, and that it does not lie in its use as an evaporometer.

Cantoni, Giovanni.

Sulle condizioni di forma e di esposizione pui opportune per gli evaporimetri. Rend. r. ist. Lomb., 1879, **12** (ser. 2): 941–6. Reviewed in Riv. sci. ind., 1880, **12**: 49. Abstract in Zeits. Oest. Ges. Met., 1881, **16**: 39–40.

Describes a modification of the Piche evaporometer, designed to remove difficulties arising from hydrostatic pressure. It is pointed out that evaporation depends not only on temperature, humidity, and area of the evaporating surface, but also on the amount of water in the dish, on the mass and thermal conductivity of the material of the dish, on the ratio between the mass of water and the surface of the dish, on the ratio between the diameter and the depth of the liquid, and on the movement of air about the dish.

Cantoni, G.

Sugli evaporometri e sulla temperatura dell'aria. Ann. uffic. cent. met. Ital., 1879, **1**(ser. 2): 47–59.

Emphasizes the importance of exposure of the evaporometer.

Cantoni, G.

Quels progrès ont fait les méthodes pour la détermination de l'évaporation? Rap. deux. congrès mét. int. de Rome, 1879: 123–4.

Distinguishes between observations of evaporation for meteorological and for agricultural purposes; and, in the former case, advises the dimensions of the atmometer be reduced to the utmost, since the difference between the temperature of the air and that of the water increases as the mass of the water in the basin and in the whole apparatus increases.

Ebermayer, E.

Bericht über die Fragen 18 (Bestimmung der Bodentemperatur), und 21 (Verdunstungsbeobachtungen), des Programme für den Meteorologen Congress in Rom. Leipsic. 1879. 8vo. Also Rap. deux. congrès mét. int. de Rome, 1879: 87–9, 91–5.

Groups instruments for measuring the evaporation of water into two classes: (1) those for scientific researches, e. g., Osnaghi's (1874), Morgenstern's, and Hough's (1874) recording; and (2) those for practical studies. The latter class should be exposed to a variety of climates.

Describes Morgenstern's instrument as consisting of a moist paper 10 centimeters by 10 centimeters, stretched on a frame and absorbing water by capillarity from a burette placed below it. This is apparently not the same form described by Symons, 1876.

Recommends form, construction, and manipulation of instruments.

Höhnel, Franz.

Ueber die Transpirationsgrössen der forstlichen Holzgewächse mit Beziehung auf die forstlich-meteorologischen Verhältnisse. Zeits. Oest. Ges. Met., 1879, **14**:286–91.

An experiment conducted from June to November compared water loss from fifteen different kinds of young trees replanted in air-tight pots, and it was found that birch lost most and black fir least. The amount of water loss was compared with the rainfall for the period.

Modena, Reale Osservatorio.

Osservazioni sulla evaporazione. Ann. soc. met. ital., 1879, **2**.

Mohn, H.

Grundzüge der Meteorologie. Berlin. 1879. 2d ed.

See Mohn, 1875.

———

Sun spots and the Nile. Nature, 1879, **19**:299.

Points out a coincidence between frequency of sun spots, increased rainfall, and increased evaporation.

Ragona, D.

Esperienze sulla evaporazione. Ann. soc. met. ital., 1879, **2**.

Ragona, D.

Évaporomètre enregistreur. Congrès de mét., Expos. univ. int. de Paris, 1878, Compt. rend. sténog., no. 20:25. 1879.

A balanced evaporating dish rises as its weight diminishes by evaporation, drawing with it a marking pointer which moves in front of but without touching a revolving cylinder. Every quarter of an hour a hammer, actuated by a clock movement, presses the pointer against the cylinder and registers the distortion of the balance, and hence the amount of evaporation.

Riegler, Wahrmund.

Das evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1879, **14**:368–74. Abstract in Forsch. Geb. Agr. Phys., 1880, **3**:111–2.

The evaporation from a free water surface is to that from a Piche evaporometer as 1:2.03. Discusses the defects and advantages of the Piche instrument.

Russell, H. C.

Meteorology of New South Wales. Results of rain and river observations made in New South Wales. Sydney. 1879.

The series appeared under various titles, as follows: 1878, Results of rain observations made in New South Wales; 1879–88, Results of rain and river observations... (1886 included observations in Queensland); 1889–94, Results of rain, river, and evaporation observations... All these reports contain results of observations of evaporation. See Symons, 1890, for amount of evaporation which Russell has found possible at Sydney and other stations in New South Wales.

Skinner, J. D.

Table of daily evaporation at the sources of the Mississippi River, autumn 1878. Rpt. Chf. Eng., 1879, pt. 2:1226–7.

The rate of evaporation from a freely exposed pan of water was shown to be nearly twice as great as that from a pan in the shade or from one set in a marsh.

Symons, G. J.

[Address by, before the Sanitary Institute at Croyden.] Symons's met. mag., 1879, **14**:164.

"Hygrometry is almost identical with the measurement of evaporation, but not quite, because hygrometry considers the amount of moisture in the air at rest, and evaporation is the resultant of the average of a variable number of miles of air of a variable hygrometric condition over a water surface."

Todd, Charles.

Meteorological observations made at the Adelaide Observatory during the year 1878. Adelaide. 1879. Review in Symons's met. mag., 1880, **15**:72–4.

The reviewer believes there is no European observatory where such judicious arrangements for measuring evaporation are in operation as these at Adelaide. One evaporator consists of a zinc-lined wooden tank 4 by 4 by 3.5 feet, sunk 3 feet in the ground. It is filled with water nearly to the top, and the level of the water is observed by means of a vertical rod moved by rack and pinion and reading by vernier to 0.01 inch. A second instrument consists of a cubical slate tank, 3 feet on a side, placed in a larger cement-lined brick tank 4.5 by 4.5 by 3.25 feet. Both are filled with water to the same level. The evaporation from the inner tank is measured on a graduated vertical rod carried by a float. A table comparing the two instruments shows less evaporation from the slate tank than from the wooden one. In 1878 the total from the latter was 58.8 inches, from the former, 69.19 inches.

Volland.

Ueber Verdunstung und Insolation, ein Beitrag zur besseren Kenntniss des Hochgebirgsklimas. Basel. Switzerland. 1879. 34 p. 8vo. Abstract in Fortsch. f. Met., 1879, **15**:102–2.

Observations made simultaneously at Davos, Switzerland, and Strassburg, Germany, of the evaporation of water from small vessels protected from sun and rain, but freely accessible to the air, show by weekly weighings that: (1) loss by evaporation is less on high mountains than on lowlands; (2) the rarer air and decreased atmospheric pressure of high altitudes has a lower capacity for water vapor, and thus retards evaporation; (3) insolation on mountain tops is lower in summer and higher in winter than on the lowlands, and for the same reason as in (2); (4) on mountain tops the air is driest in winter.

1880.

Croll, James.

Aqueous vapor in relation to perpetual snow. Amer. jour. sci., 1880, **20** (3d ser.): 103–5. Extract in Mo. weather rev., October, 1880, [**8**]:16.

Points out that snow evaporates even when the temperature is below the freezing point.

Ebermayer, E.

Beschreibung einer Methode zur Bestimmung der Durchlässigkeit und Verdunstungsgrösse der verschiedenen Bodenarten. Protokol der Int. Konf. für Agrarmet. Vienna. 1880.

Forster, A.

Ueber das Verhältniss der Angaben des Evaporimeter Piche zu denen des Wild'schen Waagevaporimeter. Jahrb. tellur. Obs. Bern. 1880. Also Forsch. Geb. Agr. Phys., 1881, **4**:466–8.

The rates of evaporation from the Piche and from the Wild evaporometers were compared from May, 1879, to October, 1880. The Piche instrument gave a rate per square centimeter of exposed surface, 1.99 to 2.22 times greater than that of the Wild instrument. (See Shaw, 1882.)

Haughton, Samuel.

Six lectures on Physical Geography. Dublin and London. 1880. p. 123.

Gives general estimates of evaporation.

Houzeau, J. C. and A. Lancaster.

Traité élementaire de météorologie. Paris. 1880. Review in Symons's met. mag., 1881, **16**:73–6.

Draws attention to the rôle played by evaporation as affecting sensible temperatures i polar regions or elsewhere under very low temperatures.

Kunze, M. F.

Das Evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1880, **15**:21–2. Review in Forsch. Geb. Agr. Phys., 1881, **4**:468; Ciel et Terre, 1881, **1**:44–5.

Experiments similar to Riegler's, 1879, compare the rate of evaporation from a Piche evaporometer and from a free water surface, from October 20 to November 14, 1879. The ratios found, 1.05, 1.12, or 1.09, are much smaller than those found by Riegler. The two instruments agreed almost exactly during the night, but during the day the Piche instrument showed a higher rate, due probably to the heating of the high thin walls of the tube.

Lancaster, A.

See Houzeau, J. C., and A. Lancaster, 1880.

Lavel.

Recherches sur l'évaporation et sur les causes qui la modifient. Mém. soc. sci. phys. et nat. Bordeaux, 1880, **3**.

Lommel, E.

Wind und Wetter. Leipsic. 1880.

Describes Prestel's (1864) atmometer on p. 49.

Masure, Félix.

Recherches sur l'évaporation de l'eau libre, de l'eau contenue dans les terres arables, et sur la transpiration des plantes. Ann. agron., 1880, **6**:441–500. Abstracts in Forsch. Geb. Agr. Phys., 1880, **4**:135–8; Symons's met. mag., 1881, **16**:67–8.

Describes measurements at Orléans, of the rate of evaporation from water, soil, and vegetation, from August 6, to November 15, accompanied by observations of the temperatures of the air and water, the relative humidity, etc. Derives the following expression for evaporation:

$$h=K\frac{F_{t'}}{H}\ (F_{t'}-UF_t).$$

where $h=$ millimeters of water evaporated in six hours, $t=$ mean temperature of the air for the six hours, $t'=$ mean temperature of the water, $F_t=$ maximum vapor pressure at the temperature of the air, $F_{t'}$ $=$ maximum vapor pressure at the temperature of the water, $U=$ mean relative humidity, $H=$ barometric pressure, $K=$ constant depending on such secondary factors as solar radiation, the weather, the wind, the electrical and chemical state of the air, etc. A table compares the rates of evaporation from soil under different conditions of moisture, and from free water surfaces, shows that wet soil evaporates more and a dry soil *less* than a free water surface. The transpiration of plants is regarded as a complex phenomenon. The average daily evaporation from a water surface at Orléans, during the period studied, was 163.8 millimeters, 48.02 millimeters in the forenoon, 101.32 millimeters in the afternoon, and 14.46 millimeters during the night.

Stelling, Ed.

Ueber den jährlichen Gang der Verdunstung in Russland. Repert. f. Met., 1880, **7**, No. 6: 1–75. Also (with a plate of curves) St. Petersburg. 1880. 4to. Abstracts in Zeits. Oest. Ges. Met., 1881, **16**:117–9; Forsch. Geb. Agr. Phys., 1881, **4**: 132–5; Fortsch.f. Met., 1881, **7**: 75–80.

A study of evaporation at 23 stations in Russia, with Wild's evaporometer, from 1872, shows the minimum to occur generally in January and the maximum in July. The form of the curve is determined by relative humidity and temperature. Weilenmann's formula is quoted as showing a mathematical relation between these elements and evaporation. The expression $V=a(G-g)$, in which $a=$ a constant, $G=$ the weight of the water vapor per unit volume of saturated air at the given temperature, and $g=$ the actual weight of the water vapor per unit volume, may also be written $V=aG\left(1-\frac{g}{G}\right)$. It is shown that $\frac{g}{G}=$ the relative humidity, r, therefore if r is expressed in per cent, the equation becomes $V=a'G\ (100-r)$. G, a function of the temperature, increases in geometrical progression as the temperature increases in arithmetical progression. This equation suggests: (1) At constant temperature the evaporation is inversely proportional to the relative humidity; (2) the influence of the relative humidity on the absolute amount of increase or decrease of evaporation is greater at high temperatures than at lower. Observations of rainfall and other meteorological elements are given, and curves present evaporation rates for eleven stations.

Wollny, E.

Untersuchungen über den Einfluss der oberflächlichen Abtrocknung des Bodens auf dessen Temperatur- und Feuchtigkeitsverhältnisse. Forsch. Geb. Agr. Phys., 1880, **3**: 325-48.

Shows that a dry surface layer to a great degree retards evaporation from the soil.

1881.

Blanford, H. F.

Description of a rain gauge with evaporometer, for remote and secluded stations. Jour. Asiat. soc. Bengal, 1881, **50** (pt. 2): 83-5. Also Proc. Asiat. soc. Bengal, 1881,(-): 76-7.

Fornioni, G.

Di un evaporimetro a livello costante. Rend. r. ist. Lomb., 1881, **14**: 356-9.

The instrument consists of an evaporating dish connected with a supply reservoir by a glass tube. A spring raises the reservoir as the water is consumed, thus keeping the water in the evaporating dish at a constant level. The movement of the reservoir is transmitted by means of a thread and pulley to the pointer of a dial which indicates the amount evaporated.

Forster, A.

Ueber den täglichen und jährlichen Gang der Verdunstung in Bern. Jahrb. tellur. Obs. Bern, 1881, (—): 5–7. Abstract in Forsch. Geb. Agr. Phys., 1881, **4**: 465–6.

Observations were made twice daily of the rate of evaporation from a Wild evaporometer exposed in a thermometer shelter, from March, 1878, to December, 1880. The maximum daily amount for this period, 49 millimeters, occurred in July, 1880, and the minimum, 2.5 millimeters, in December, 1879.

Garban.

On the rate of evaporation. Paper read at the Réunion annuelle des sociétés savantes in Paris in 1881. Abstract in Symons's met. mag., 1881, **16**: 66.

According to Ramsay (1884), Garban's experiments on the rate of evaporation from various soils showed a lower rate from chalk than from sand, the latter appearing to collect most dew and vapor and to yield its vapor more readily than any other variety of soil.

Gilbert, J. H.

See Lawes, J. B.

Gugliemo, G.

Sulla evaporazione dell' acqua e sull' assorbimento del vapore acqueo per effetto delle soluzioni saline. Turin. 1881. 8vo. 21 p.

Kunze, M. F.

Das Evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1881, **16**: 30–1.

The experiments described in Kunze's paper of 1880 were continued from April to October, 1880. They give 0.670 as the ratio of evaporation from a free water surface to that from the Piche instrument for April, and 0.732 for July.

Lawes, J. B., J. H. Gilbert, and R. Warington.

On the amount and composition of the rain and drainage waters collected at Rothamsted. Parts I and II. Jour. roy. agr. soc., 1881, **17** (ser. 2): 241–79, 311–50.

Description of the elaborate means employed at Rothamsted to isolate in its natural condition a plot of soil. A table of rainfall, drainage, and evaporation for the period 1870–80 shows the annual evaporation ranging from 14.279 to 19.686 inches. Finds that the average evaporation from soil bare of vegetation, in a climate having a mean temperature of 48° F., will be nearly 12 inches during the six summer months, about 5.5 inches during the six winter months, and 17 to 18 inches for the whole year. Discusses the results obtained by others along this line, describes the form of Dalton's percolation gage, as used by Maurice, Gasparin, Dickinson and Evans, Greaves, Ebermayer, Sturtevant, etc. In all these cases the soil was too loose to approximate the natural conditions and grass was allowed to grow, thus increasing the evaporation. Gives Graves's [Greaves'?] results from a similar experiment with a mass of pure sand, showing the average drainage and evaporation for the fourteen years, 1860–73.

Ragona, D.

Andamento diurno e annuale della evaporazione. Mem. reg. accad. sci. Modena, 1881, **1**, (ser. 2). Also Modena. 1881. 28 p. 4to. Reviewed in Zeits. Oest. Ges. Met., 1882, **17**: 242-3; Ann. soc. mét., 1882, **30**: 35–7.

The reviewer doubts Ragona's statement that there is no daily periodicity in the rate of evaporation as shown by his self-recording evaporometer (see Ragona, 1879); also that the winter months show a negative evaporation. These apparently incorrect observations are attributed to the method used.

Russell, Henry Chamberlain.

Evaporation. Min. proc. intercol. met. conf. at Melbourne, April, 1881. Melbourne. 1881. 4to. p. 12–13.

Results of observations with three forms of evaporators, 1871–1880.

Shaw, W. N.
Report on hygrometers and evaporimeters, presented to the Meteorological Council May 10, 1881. Metl. council rpt., 1881, (—): 28–30.

Instruments of the same pattern as described in Shaw, 1877, are used in these experiments. The different forms gave the following widely divergent results:

Instruments.	Evaporation.
	Mm.
Lamont	3.88
de la Rue (1)	3.61
de la Rue (2)	3.16
Wild	2.85
Piche	97.3

Estimates that 20 millimeters of the Piche scale are equivalent to 1 millimeter of evaporation from a free water surface.

Stefan, J.
Ueber die Verdampfung aus einem kreisförmig oder elliptisch begrenzten Becken. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1881, **83** (pt. 2): 943. Abstract in Zeits. Oest. Ges. Met., 1882, **17**: 63–8.

A study of the laws of evaporation from circular and elliptical vessels brings out the facts that, whereas one would expect a much higher rate of evaporation from an elliptical surface than from a circular one of equal area, this is only the case for those ellipses whose major axis is many times greater than the minor one. Otherwise the evaporation from an elliptical surface is but little greater than from a circular one. The evaporation from a large water surface is relatively less than that from a small one, because the amount of vaporization is not proportional to the area but to the square root of the area.

Stefan, J. and Maxwell, [J. C.]
Theorie des Psychrometers. Zeits. Oest. Ges. Met., 1881, **16**:177–82.

Mathematical discussion of the laws of psychrometry. German translation of J. C. Maxwell's article, "Theory of the wet-bulb thermometer," Encyc. Brit., 9th ed., vol. 7, p. 218–19, article "Diffusion." Edinburgh. 1877.

Stelling, Ed.
Ueber die Bestimmung der absoluten Grösse der Verdunstung von einer freien Wasserfläche nach den Beobachtungen im Observatorium in Pawlowsk. Repert. f. Met., 1881, **8**, (Kl. Mitt. No. 2):10–9. Review in Zeits. Oest. Ges. Met., 1882, **17**: 373. Ciel et Terre, 1883, **3**: 214.

Wild, at Pavlovsk in the summer of 1878, found that the temperature in his floating evaporometer was sometimes as much as 10° C. higher than that of the water in the pond. In 1880 the apparatus was altered so that the two temperatures agreed very closely. Calculations by the Dalton-Weilenmann formula (Weilenmann, 1877) showed that the indications of the evaporometer could then, with hardly any correction, be taken as the evaporation from the free surface of the pond. The formula is $v = A\Sigma\,(S-s) + B\Sigma\,(S-s)w$. A and B are constants under general conditions, v = the rate of evaporation, S = the vapor pressure of saturation at the temperature of the water, s = the vapor pressure at the dew-point, and w = wind velocity in meters per second. Describes his floating instrument.

Symons, G. J.
A contribution to the history of hygrometers, (read March 16, 1881). Quart. jour. roy. met. soc., 1881, **7** (n. s.):161–185.

Gives a chronological list from 1644 to 1879 of the inventors of hygrometers, with a brief description of each instrument. Also an alphabetical list of the same with bibliographic references.

Symons, G. J.
Evaporation. Brit. rainf., 1881, (—): 46.

A general discussion of the influence of the size of the evaporator on the rate of evaporation, and of the necessity of using large evaporating surfaces to secure results comparable with the actual evaporation from large natural bodies of water. Gives the recommendations of the Agricultural Congress at Vienna in 1880 regarding study of evaporation.

Violi, A.
Sull' evaporazione dell' acqua. Rend. r. ist. Lomb., 1881, **14**:576–80.

The influence of the area of the evaporating surface upon the rate of evaporation is considered subordinate to that of the temperature and relative humidity.

Warington, R.
See Lawes, J. B., etc.

Wollny, E.

Bericht über die Verhandlungen und Ergebnisse der internationalen Conferenz für land- und forstwirthschaftliche Meteorologie, abgehalten in Wien in den Tagen vom 6–9, September, 1880. (Aus den Sitzungsprotokollen zusammengestellt und mit Bemerkungen versehen.) Forsch. Geb. Agr. Phys., 1881, 4: 276–305. Translated in Quart. jour. roy. met. soc., 1881, 7:117–20.

[Wollny, E.]

Resolutions adopted by the Conference for the development of Agriculture and Forest Meteorology, held at Vienna in September, 1880. Quart. jour. roy. met. soc., 1881, 7: 117–20.

"The Conference is of the opinion that observations of evaporation are important, but that no existing instrument can be proposed for general and exclusive use. In fact it is recognized as an immediate requirement to devise satisfactory instruments and especially such as would admit of the accurate measurement not only from free water surfaces but also from different soils in the fallow and cropped states. Meanwhile, observations on evaporation should not be neglected, but they should be conducted with simple forms of apparatus, especially those depending on weight, as well as with the Piche atmometer modified according to the suggestions of Professor Cantoni." (See Cantoni, 1879.)

1882.

Carl, Philipp.

Ein einfacher Verdunstungsmesser. Repert. der Phys., 1882, 18: 630–1.

An evaporating vessel is laterally connected by a rubber tube with a graduated glass cylinder, which can be raised and lowered. The zero point of the scale is brought to the same level as the opening from the evaporating dish into the connecting tube. Water is poured into the apparatus until it stands at this level. The graduated cylinder is then raised so that water rises and fills the evaporating dish. At the end of a definite period the fall of the water level in the graduated vessel can be directly observed.

———

L' évaporation. Ciel et Terre, 1882, 3:91–2.

Discusses the questions raised by Tacchini, de Lesseps, and Symons, regarding the necessity of large evaporating vessels for approximating natural conditions. Concludes that the rate of evaporation increases in proportion as the size of the evaporometer employed diminishes.

Cunningham, Allan.

Recent hydraulic experiments. Proc. inst. civ. engin., 1882, 7:1–36.

Measurements of evaporation were made on the Ganges canal near Roorkee in northern India for 25 months, during 1876–9. The evaporator was a zinc pan, 12 by 12 by 9 inches, resting in a wooden frame and buoyed by air chambers so as to float on the surface of the canal. The observed rate of evaporation was remarkably low, the average being only 0.10 inch per day; whereas 0.50 inch per day is said to be a common rate for Indian land exposures. The cause of the low rate appears to be the extreme coldness of the canal water which is from the snow-fed Ganges. On May 22, 1877, at 2:30 p. m., the air temperature was 165° F. in the sun, and 105° in the shade, while the water was only 66° inside the pan and 65° in the canal. The highest recorded temperature of the canal water was only 75.5° F. The total evaporation from the whole surface of the canal and its branches was estimated at about 47 cubic feet per second, about 1/150 of the full supply of the canal or the entire supply for ten minutes daily.

Decaudin-Labesse.

Marche diurne et annuelle de l'évaporation, par le Prof. D. Ragona, directeur de l'Observatoire de Modène. Ann. soc. mét., 1882, 30:35–7.

Many variations but no certain periodicity, are shown in Ragona's curve of daily evaporation (see Ragona, 1881.) The influence of wind on evaporation is shown to be such that "if all other instruments were lacking, the self-recording evaporometer would suffice to indicate strong gusts of wind, even when the evaporometer is sheltered." Ragona's formula is $E=0.18259T-0.01823U+0.15145F$, where T=temperature, U=relative humidity, F=the velocity of wind in kilometers per hour. The reviewer expresses surprise at evidences of "negative evaporation." The differences between the temperatures of the air and dew-point are tabulated, showing that this difference is very small in winter when "negative evaporation" often occurs. The rate in a closed sunless place seems to be governed by the same laws as those for an open sunny place. The maxima and minima for the year follow those of the temperature. The total annual evaporation at Modena is determined as 2223.10 millimeters.

Dewar, D.

A new theory of Nature; containing observations on weather, tides, capillary attraction, evaporation, and sun-spots. London. 1882.

In experiments with evaporation from water in capillary tubes, it was shown that in vessels having surfaces and bases of equal areas, the smaller the free surface and the less the height of the liquid the greater is the evaporation.

Freeman, S. H.

On the question of electrification by evaporation. Phil. mag., 1882, **13** (5):398–406. Notice in Ciel et Terre, 1883, **4**:287–8.

The theory that evaporation is the source of atmospheric electricity, first proposed by Volta and upheld more or less by Pouillet, Tait, and Wanklyn, is here controverted. "If the charges of electricity produced in experiments with evaporation are really due to evaporation (and not to friction and leakage, as is more probable), and if evaporation is the principal source of atmospheric electricity, the calculations of the amount of evaporation necessary to produce one flash of lightning show that a much greater quantity of water would be required than is ever found in a thunder cloud." Further the total annual evaporation from the earth will not account for the annual number of lightning flashes usually observable from any one place.

Langer, Th.

Vergleichende Beobachtungen mit dem Evaporimeter Piche unter vielerlei Exposition. Forsch. Geb. Agr. Phys., 1882, **5**:105. Abstract in Zeits. Oest. Ges. Met., 1882, **17**:375.

Experiments comparing the rate of evaporation from four Piche atmometers in different exposures, were conducted during the summer months of 1880, accompanied by observations on the temperature of each, the cloudiness, relative humidity, pressure, and wind velocity. The rate increased with the degree of exposure. The Piche, and particularly the form as modified by Cantoni (1879), is recommended for the purposes of agricultural meteorology.

Latham, B.

Experiments with Greaves's floating evaporator. Proc. inst. civ. engin., 1882, **71**:47. (In the discussion following the paper by Cunningham, 1882.)

For a general description of this apparatus see Symons, 1869. In these experiments the author brings out the fact that too high evaporation rate may be produced by the capillary action of the water on the sides of the vessel. From a number of evaporators painted different colors the rate was always higher, even from the black, than from the plain copper, because the painted surfaces induced greater capillary action than metal. Further experiments show the influence of the size of the vessel, the larger the vessel in proportion to the surface exposed to evaporation, the smaller is the marginal ring up which the water passes by capillarity and the less is the evaporation rate.

Robie, David.

Rain and Dalton gages. A letter to the Editor. Symons's met. mag., 1882, **17**:184–6.

Experiments with the Dalton gage at Bedford, England, showed that in 1882 almost half the 28.42 inches of rainfall was evaporated. The monthly percentages of this amount that percolated into the soil were as follows: January, 83; February, 50; March, 68; April, 43; May, 54; June, 20; July, 51; August, 8; September, 40; October, 46; November, 67; December, 94. Dalton gages of various depths in operation at Rothamsted show that the moisture in the soil may be drawn up from considerable depths by evaporation, one gage being 5 feet deep.

Sresnevski, Boris.

Ueber die Verdampfung von Flüssigkeiten. Jour. Russ. phys. chem. soc., 1882, **14**:420–69, 487–98. Abstract in Beibl. Ann. Phys. und Chem., 1883, **7**:888–90.

In the investigation of an atmometer constructed by Petrushevski, which allows evaporation not from a flat surface but from the curved surface of a drop segment (Tropfensegmente), it developed that the amount of evaporation is proportional to the circumference of the segment and not to the surface. This confirms the conclusion reached theoretically by Stefan in 1881, that the amount of liquid evaporation from a circular hole in a flat surface should be proportional to the circumference of the hole.

Stelling, Ed.

Ueber die Abhängigkeit der Verdunstung des Wassers von seiner Temperatur und von der Feuchtigkeit und Bewegung der Luft. St. Petersburg. 1882. 42 p. 4to. Also Repert. f. Met., 1882, **8**: No. 3. Abstract in Zeits. Oest. Ges. Met., 1882, **17**:372–3.

Observations of the evaporation (by a Wild evaporometer) and other meteorological elements were made every two hours at Nukuss from May to September, 1875. He uses the Dalton-Weilenmann formula [see Stelling, 1881], $dv=A\,(S-s)\,dz+B\,(S-s)\,wdz$, in which dv=the evaporation in millimeters for the time dz, S=the vapor pressure of saturated air at the temperature of the evaporating water, s=the actual vapor pressure of the air in millimeters of mercury, w=the wind velocity in kilometers per hour, and A and B are constants evaluated from the observed evaporation depth. Concludes that the Dalton-Weilenmann formula is reliable to within $\pm$ 10 per cent of the actual depth of evaporation in the open and to within $\pm$ 15 per cent of that depth under a shelter.

van Tricht, P. Victor.

Évaporomètre à plongeur. Ciel et Terre, 1882, **3**:430–2.

Describes in detail the design of an evaporometer of the Lamont (1868) type.

———. Verdunstungsmesser in Pawlowsk. Zeits. Oest. Ges. Met., 1882, **17**: 367–8.

Describes and illustrates the floating evaporometer devised by Wild and described by Stelling, 1881.

Wiedemann, Gustav.
Die Lehre von der Electricität. Braunschweig. 1882. 5 vol.

In **1**: 240–1 and **4**: 628–9, there is a general discussion of the generation of electricity by evaporation, and of the influence of electrification on evaporation.

1883.

Blake, Lucien.
On the production of electricity by evaporation, and on the electrical neutrality of vapor arising from electrified still surfaces of liquids. Phil. mag., 1883, **16**(5): 211–24. Reviewed in Ann. Phys. und Chem., 1883, No. 7; Zeits. Oest. Ges. Met., 1882, **17**:482; Ciel et Terre, 1883, **4**: 311–12.

Two different methods of experimentation lead to the conclusion that "the charge [produced by evaporation from sea-water] is too small in proportion to the sea-water evaporated, to be used as a basis for mathematical calculations concerning the electricity resident in the clouds [see Freeman, 1882]. Nor is it a sufficient ground for the assertion that the simple change of a liquid into a vapor produces electricity." Other experiments seem to show that "the vapor arising from electrified still surfaces of liquids is electrically neutral."

———. L'eau tombée et l'évaporation à la surface de la terre. Ciel et Terre, 1883, **4**: 18–20.

Abstract of John Murray's estimates of evaporation from rainfall and run-off.

Dieulafait.
Évaporation de l'eau de mer dans le sud de France et en particulier dans la delta du Rhône. Compt. rend., 1883, **96**: 1787–90.

From experiments on the French Mediterranean coast in the region of the delta of the Rhone, it is concluded that the average daily evaporation from sea-water, even at some distance out from land, is at least 6 millimeters.

Dieulafait.
Évaporation des eaux marines et des eaux douces, dans la delta du Rhône et à Constantine. Compt. rend., 1883, **97**: 500–2.

The ratio between the evaporation of salt water and fresh, stated by Roudaire as 62:100 is believed to be inexact. The ratio found by the weighing method was not lower than 96.5:100, and it is shown that theoretically this ratio is not less than 98:100 for normal sea water. Observations conducted by Pelletreau at Constantine show an average daily evaporation of 8 millimeters from May 1 to December 1, 1881. The daily average for the year is calculated as 6.6 millimeters or 6.3 millimeters from sea water.

Lalanne.
[Note on a paper by Salles.] Compt. rend., 1883, **97**:349–50.

In connection with Roudaire's plan of an inland sea, the experiments of Salles, 1883, are mentioned as showing that evaporation is not so great from large bodies of water as observations of evaporation from small instruments seem to indicate.

Latham, B.
Evaporation from irrigated rye grass at Croydon. Proc. inst. civ. engin., 1883, **73**:238.

In discussing O'Meara, 1883, the author cites experiments on the rate of evaporation from an artificially isolated plot of irrigated rye grass, showing a loss by evaporation of 183.3 inches from June 18, 1870, to June 12, 1871, while the rainfall for that period was 20.03 inches.

O'Meara, Patrick.
The introduction of irrigation into new countries, as illustrated in northeast Colorado. Proc. inst. civ. engin., 1883, **73**:178–212.

Discussion of problems arising in an investigation of irrigation possibilities, such as evaporation from soil, evaporation of snow, and evaporation from reservoirs.

Ragona, D.
Andamento diurno e annuale della evaporazione. Mem. reg. accad. sci. Modena, 1883, **1** (ser. 2):145–70.

This article is mainly occupied with errors and corrections of the formula developed in Ragona, 1881 (see Decaudin-Labesse, 1882). The effect of wind on evaporation is illustrated by a typical daily curve.

Salles, A.

Expériences sur l'évaporation faites à Arles pendant l'années 1876 à 1882. Comp. rend., 1883, **97**:347–9.

Observations of the evaporation from water in three masonry tanks 3 meters square, with the surface of the water at various levels. Special instruments were designed for accurate measurements. The average annual evaporation was 1.050 meters. A Piche atmometer gave 2.200 meters. Previous observations by Gasparin at Orange (sixteen years) gave 1.876 meters; by Cotte at Cavaillon (two years), 2.192 meters; by Cotte at Arles (five years), 2.563 meters, and by Valles at Marseilles, 2.350 meters. The Ingénieurs de ponts et chaussées at Dijon found 0.594 meter from large basins of masonry.

Sresnevski, Boris.

Ueber die Verdampfung von Flüssigkeiten. Jour. Russ. phys. chem. soc., 1883, **15**:1–9.

Concludes his paper of 1882.

Tromelin, G. le Goarant de.

La grêle, les trombes, l'électricité atmosphèrique. Rev. sci., 1883, pt. 1 (—):779–85. Translated in Phil. mag., 1884, **17** (5):245–7.

Believes that atmospheric electricity results from the friction present in wind-caused evaporation; but does not believe quiet evaporation can produce electricity in unchanged air.

1884.

Abbe, Cleveland.

Progress in meteorology in the year 1883. Ann. rept. Smithsn. inst. for 1883. Washington. 1884. p. 27, 43, 65.

Summarizes Stefan's (1881) investigations, discusses the relation of evaporation to electricity according to Blake (1883), describes the Stelling and Wild evaporometer, (see Stelling, 1881), and reviews Langer's (1882) results with a Piche instrument.

Acireale, Osservatorio Meteorologico Pennisi.

Riassunto delle osservazioni meteorologische 1882–3. Acireale. 1884.

A table of humidity, evaporation, and rainfall for 1882–3 gives totals by decades and months. The total observed annual evaporation was 1694.2 millimeters and the rainfall 967.5 millimeters.

Decaudin-Labesse.

See H. Mohn, 1884.

Descroix, Léon.

Sur l'exagération du pouvoir évaporant de l'air à l'équinoxe du printemps. Compt. rend., 1884, **98**:1352–5. Abstract in Ann. soc. mét., 1884, **32**:209.

From observations with a Piche evaporometer it is concluded that "general vaporization of pure water at the surface of the paper varies as the ratio between the square of the number which measures the lowering of the dew-point on one side and the atmospheric temperature on the other." The author notes an increase in the evaporating power of the air in the spring, also the fact that evaporation under widely different temperatures, (11° C., afternoon in spring, 22° C. in midsummer), may be absolutely the same, although the relative humidity is not lower in April than in July. A table gives the comparative range of evaporation and related meteorological phenomena from 1873–84.

Eser, Carl.

Untersuchungen über den Einfluss der physikalischen und chemischen Eigenschaften des Bodens auf dessen Verdunstungsvermögen. Forsch. Geb. Agr. Phys., 1884, **7**:1–124. Review in Met. Zeits., 1885, **2**:430–2. Abstract in Fortsch. f. Met., 1885, **11**:37–41.

Includes critical reviews of the work of Schübler, Meister, Wolff, Nessler, Hellriegel, Haberlandt, Johnson, etc., on transpiration and evaporation from soil. From the author's own experiments it is concluded: (1) Evaporation depends mainly on the amount of water in the soil; all soils evaporate equally when saturated. (2) The evaporating surface is at the surface until the saturation of the soil is less than 50 per cent when the evaporating surface sinks. (3) Evaporation depends on the porosity of the upper layers and is decreased by the drying of the surface. (4) Soils of a high rate of evaporation lose less water as they dry out than those having a lower rate. (5) Evaporation from a rough surface is greater than that from a smooth surface. (6) The physical structure and organic content of the soil are of primary importance because of the water capacity and capillarity; humus evaporates most, sand least, and clay is intermediate. (7) Evaporation is greater from the darker colored soil. (8) The soil covering is more important than the soil itself; plant-covered soil evaporates most, bare soil next, straw-covered land least. (9) Capillarity may cause salts to accumulate at the top. (10) Manures containing salts retard evaporation by increasing the salt content of the surface layer. (11) Inclined surfaces evaporate moisture at rates in the following order, south, east, west, and north. (12) Evaporation varies with the seasons. (13) Evaporation is in proportion to insolation.

Mohn, H.

Les phénomènes de l'atmosphère. Traduit par Decaudin-Labesse. Paris. 1884. p. 25, 105–12, 114, 129.

Discusses the rôle of water vapor in the movements of the atmosphere. Defines and states laws of evaporation and heat of vaporization. Describes and figures the Delahaye evaporometer. General discussion of the causes which determine the amount of evaporation. Figures for total annual evaporation given for different localities.

Ragona, D.

Andamente annuale della evaporazione. Ann. met. ital., Ser. II, 1884, **6** (pt. 1): 57–67. Also Rome. 1886. 16 p. 4to.

Devises a mathematical expression, employing the meteorological elements, by which the calculated evaporation agrees closely with the observed evaporation at Modena for five-day periods from 1879–1885. The instrument used was a simple cylindrical glass dish with a device for obtaining accurate readings of the level of the water.

Ramsay, Alexander.

A bibliography, guide, and index to climate. In the Scientific Roll and Magazine of Systematized Notes. London. 1884.

For evaporation see under Aqueous Vapor: Bibliography, 1682–1883 (incl.) and Notes, p. 177–449.

Symons, G. J.

Evaporation. Brit. Rainf., 1884, (—): 9.

Notice of the removal to Camden Square, early in 1883, of the large tank (Symons, 1870) which had been used for observing evaporation at Strathfield Turgiss.

Viñes, Benito.

Observaciones magneticas y meteorologicas del Real Colegio de Belen de la Compañia de Jesus de Habana, Ano de 1875. Habana. 1884. 4to.

Evaporation records for Habana, Cuba.

Wollny, E.

Untersuchungen über die Wassercapacität und das Verdunstungsvermögen verschiedener Streumaterialien. Forsch. Geb. Agr. Phys., 1884, **7**: 309–321.

Soil mulches, peat, loam, and sand, allow greater evaporation than mulches of dead plant parts. Among the last the moss mulch allows greater evaporation than one of needle leaves or of broad leaves, the latter being the most effective in retaining soil moisture.

1885.

Acireale, Osservatorio Meteorologico Pennisi.

Riassunto delle osservazioni meteorologiche, 1883–4. Acireale. 1885.

Table of evaporation, rainfall, and humidity for 1883–4. Total evaporation, 1686.1 millimeters, and rainfall, 942.3 millimeters.

Chabaneix, J.-B.

Évaporomètre du sol. Bul. mét. Hérault, 1885, (—): 79–86.

Describes a complicated arrangement for isolating soil in order to determine the rate of evaporation of its moisture. A zinc evaporating vessel, 30 by 30 by 30 centimeters, is filled with soil and buried in the ground. A spout from a gutter around the upper edge leads the excess of rainfall to a bottle. An underground reservoir supplies water by capillarity to the soil experimented with. Water is introduced into the reservoir, and thence to the whole apparatus, by a tube leading from the surface of the soil.

Guillemin, Amédée.

Le Monde Physique. Paris. 1885. 5 vol.

Descriptions are given of the Piche and the Delahay evaporometers, and a self-recording weighing apparatus, for determining evaporation from soils and plants. Tables of observations with the Piche instrument compare the rates of evaporation for day and night, also for summer and winter. Another table gives the annual evaporation in different parts of the world and the total annual evaporation from the earth's entire surface. (Volume 5, p. 223–8.)

Haslam, E.

Measurement of evaporation. Nature, 1885, **32**:357.

Describes a differential evaporometer in which water flows from a reservoir through an evaporating tank into an overflow receiver. The loss from the reservoir minus the gain in the receiver equals the evaporation from the exposed surface.

Houdaille, F.

Études des pluies de 1885. Bul. mét. Hérault, 1885, (—):41–60.

A comparison of monthly rainfall with the simultaneous evaporation furnishes a factor expressing the relative humidity of each month.

Houdaille, F.

Sur les lois d'évaporation. Compt. rend., 1885, **100**:170–2.

Dalton's formula, $E=B\frac{F-f}{H}$, where $E=$ evaporation from a unit surface in a unit of time, $F=$ the vapor pressure at the surface of the liquid, $f=$ the vapor pressure of the air, $H=$ the atmospheric pressure, and $B=$ a constant determined by the extent of the evaporating surface, is found not to apply to observations with the Piche evaporometer when the wind effect is considered. Confirms Dalton's discovery that evaporation from large evaporating surfaces is proportional to $F-f$. The evaporation in milligrams per hour per square centimeter from a surface of 13 $cm^2 = 1.46\ (F-f)$, but the least agitation of the air alters the relation. Experiments show that an air current with a velocity of 0.25 meter per second raises evaporation from 4.4 to 13.8 milligrams per square centimeter per hour. Develops a formula for the Piche instrument.

Houdaille, F.

Sur l'évaporation dans l'air en mouvement. Comp. rend., 1885, **101**:428–31.

Shows that the temperature of the Piche atmometer is intermediate between that of the air and that of the wet-bulb thermometer. The rate of evaporation per square centimeter expressed in milligrams per hour, as determined by experiments with temperatures from 6° to 28°C., humidities from 42 to 82 per cent, and an air velocity of 9.0 meters per hour, is exactly given by the relation,

$$P=\frac{62\ (F-f)}{1+0.24\ (F-f)},$$

where $P=$ the evaporation rate and $F-f=$ the difference between the vapor pressure at the water surface and in the free air. Evaporation is greatly influenced by air movement up to a certain velocity, but beyond that it is but slightly affected. Evaporation, P, in a current of air of any velocity will be

$$P=\frac{p}{1+0.5V}+\frac{25.1\ (F-f)}{1+0.24\ (F-f)}\ (V+5\sqrt{V}),$$

where $p=$ the evaporation in quiet air, and $V=$ the wind velocity. A table compares calculated and observed evaporation at different wind velocities.

Jackson, Louis d'Aguilar.

Statistics of hydraulic works and hydrology of England, Canada, Egypt, and India. London. 1885. 8vo.

It is stated, p. 427, that the annual evaporation from Rajputana Tanks for the years 1882–3 was 8.4 feet where exposed to wind, and 4.8 feet where sheltered, the annual rainfall being 2 feet. On p. 455 he states that the amount of evaporation from Vahar Tank, north of Bombay, was 2.5 feet in the eight months of the dry season.

Sprung, A.

Lehrbuch der Meteorologie. Hamburg. 1885.

Discussion (p. 312–13) of the molecular physics of evaporation, and the conditions most favorable for it. In a mathematical discussion of the subject he quotes the formula devised by Weilenmann (1877). Quotes Chapman, 1855, and Ragona, 1867, on the relative evaporation from salt water and fresh water.

Symons, G. J.

Evaporation. Brit. rainf., 1885, (—):9.

Reports evaporation observations of the Strathfield Turgiss tank continued at Camden Square, where the tank is sunk 1 foot 8 inches in a grass plot. A table of observations accompanies the notice.

Tait, P. G.

On evaporation and condensation. Abstract in Proc. roy. soc. Edinb., 1885, **13**:91–5.

Discusses the necessity for condensation nuclei.

1886.

Chabaneix, J. B.

Mémoire sur l'évaporation du sol. Bul. mét. Hérault, 1886, (—): 84–94.

Shows that the cultivated soils evaporate less than the natural soils. Different soils present different ratios, varying from 0.75 to 0.48. In this bulletin are given curves of temperature, relative humidity, and daily evaporation. See Chabaneix, 1885, for description of method.

Fitzgerald, Desmond.

Evaporation. Trans. Amer. soc. civ. engin., 1886, **15**:581–645. Abstracts in Proc. inst. civ. engin., 1887, **88**:516–7; Sci. Amer. sup., 1886, **21**:8693–4; Van Nostrand's engin. mag., 1886, **35**:41–3; Amer. met. jour., 1889, **6**:7–8. Quoted by Rafter, 1903.

Defines the rate of evaporation as the difference between evaporation and condensation. Other things being equal, the difference between the temperature of the water and that of

the dew-point determines evaporation. The principal points to be considered in a study of atmospheric aqueous vapor are: Temperature of the air, dew-point, vapor pressure, absolute and relative humidity, saturation deficit, and the weight of a cubic foot of air at the time of the observation.

Experiments upon the influence of heat on evaporation, E, gave

$$E=0.014\,(V-v)+0.0012\,(V-v)^2,$$

where V=vapor pressure of saturation at temperature of the water surface and v=prevailing vapor pressure of the air. In experiments to determine the influence of wind, the evaporating pans were moved into the open air and anemometers were placed at the level of the water in the pans. The formula for evaporation then becomes, w being the wind velocity in miles per hour:

$$E=[0.014\,(V-v)+0.0012\,(V-v)^2]\,(1+0.67\,w^{\frac{3}{5}}).$$

An approximate formula sufficiently accurate for most purposes is

$$E=\frac{(V-v)\,(1+\frac{1}{2}\,w)}{60}.$$

Concludes with Stelling and Daniell, that ordinary barometric changes are so slight that they can not materially affect the result. A large number of trials show that if observations are taken with sufficient accuracy and frequency very exact results may be obtained by use of the above formula, whether the experiments are conducted in the sun or shade.

Describes an instrument recording continuously air temperature, wind velocity, and evaporation, devised in 1884 and installed at the Chestnut Hill, Mass., reservoir. Records by this and other instruments show that the maximum evaporation does not occur on the hottest days, but may be expected on a cold day preceded by warm weather. Describes evaporation studies at Beacon Hill Reservoir, discusses evaporation in the winter, and reviews the work of Williams, Greaves, Miller, Dines, Latham, Field, Salles, and Wild. Regards measurements of the evaporation from small dishes not immersed in water as not even approximating the losses from a large body of water. (See Bigelow, 1907.)

Harreaux et Gruget.

La pluie et l'évaporation dans la Beauce. Bul. assoc. sci. de France, October 1886, (—): 58. Abstract in Ann. soc. mét., 1887, **35**:32.

Observations showed that from 1873–1877 the soil evaporation exceeded the rainfall; from 1877–1886 the soil received more water than it lost. Believes that springs are caused by an excess of rain over evaporation, and considers 1000 millimeters the excess necessary to so moisten the lower layers of soil that springs will flow.

Houdaille, F.

Marche comparée de la pluie et de l'évaporation aux divers mois de l'année. Ann. soc. mét., 1886, **34**: 191–2.

The dryness of a climate is expressed by $\frac{P-E}{E}$, in which P=the rain retained in the soil, E=the evaporation from soil and plants during an equal period. These are deduced from the rainfall, P', and the evaporation, E', as indicated by the Piche evaporometer. The monthly values of $\frac{P-E}{E}$ at Montpellier, for the decennial period, 1875–1884, show that the dry period commences in February, is interrupted in April, and finishes in August, the most humid month being January, and the driest July. In order more nearly to approach the value of P the rain intensity was studied with a recording rain gage. Derives a formula for the rate of evaporation from the Piche instrument.

Houdaille, [F.]

Marche annuelle de l'humidité du sol. Bul. mét. Hérault, 1886, (—): 53–64. Pl. 3.

Conclusions: (1) Evaporation from a soil depends on its physical properties, particularly on its clay content, on its faculty of imbibition, and the rate of capillary ascent of water in the dry soil. (2) In a soil possessing a high power of imbibition the variations of humidity at 0.5 meter depth have never exceeded one-fifth of the maximum water content, which has amounted to 19.1 per cent in clayey soil and to 15.9 per cent in less compact calcareous clay soil. (3) The date of minimum soil humidity has not been connected with a certain season, it results at once from the value of evaporation measured in the air and the length of the intervals of time which separate the consecutive rainfalls.

Marié-Davy, F. et H.

Évaporation du sol et des plantes. Jour. agr. prat., 1886, **1**: 857–8. Noticed in Forsch. Geb. Agr. Phys., 1888, **10**:66.

A brief note on the ratio of percolation to rainfall in case of enclosed masses of soil with and without vegetation. The amount evaporated is derived by subtraction.

Ragona, D.

Sul periodo diurno della evaporazione. Nota. Turin. 1886. 7 p.

Presents tables of precipitation, wind direction and velocity, temperature, and evaporation, observed every two hours in October, 1885, with pentad means. The calculated evaporation shows close agreement with measurements made with a micrometer gage. The calculated curve shows two maxima and two minima, occurring at equal intervals of 6 hours each. The principal maximum falls with the maximum temperature, but the principal minimum lags two to three hours behind the minimum temperature. The author considers that further experiments are necessary before accepting the secondary maximum and minimum.

Ragona, D.

Evaporazione comparata, etc. Ann. met. ital., 1886, parte I. Author's abstract in Met. Zeits., 1889, **6**: [31].

The evaporation in Mexico, in the shade, both observed and calculated, is compared with that at Modena. The rate is higher in Mexico from October to April, and lower from May to September. A comparison of the evaporation in the sun for both places shows similar differences in the rates. In both cases the rates for the two regions become equal toward the last of September and the last of April. The ratio between the evaporation in sun and shade was calculated, and a table compares the ratios obtained for Mexico and Modena. The annual curve of this ratio is shown to be identical with that of the relative humidity. The relation of the maximum and minimum to the spring equinox and the solstices is discussed.

Russell, Thomas.

Differences of still and whirled psychrometers. Mo. weather rev., 1886, **14**: 299–300.

Emphasizes statistically the need of active ventilation of the wet- and dry-bulb psychrometer.

Shidlovski, F.

Diffusion der Gase and Dämpfe durch poröse Körper. Jour. Russ. phys. chem. soc., 1886, **18**(6): 182–204. Abstract in Beibl. Ann. Phys. und Chem., 1887, **11**: 618–20.

Discusses the rate of the diffusion of vapor through a porous cylinder.

Symons, G. J.

On the evaporation from a water surface. Brit. rainf., 1886, (–): 14–17.

Describes the method of observing the evaporation from the large tank at Camden Square. A small still-well is made by means of a box, 4 by 4 by 12 inches, having a small hole in the bottom. By means of the hook-gage variations in the level can be read to 0.01 inch.

Teisserenc de Bort, Léon.

Météorologie. Rev. sci., 1886, **36**: 528–32.

Teisserenc de Bort, Léon.

L'évaporation. Résumé d'un travail de M. Ragona et des recherches plus récentes de M. Houdaille. Ciel et Terre, 1887, **2**: 510–12.

Review of Ragona, 1886, (1st title). Gives Houdaille's formula (see Houdaille, 1885, 3d title).

Venukoff.

Sur la vitesse de desséchement des lacs dans les climats secs. Compt. rend., 1886, **103**:1045. Abstract in Ann. soc. mét., 1887, **35**:18.

From the statement of the Russian explorer, Nicolski, that the level of Lake Balkash, (area about 19,000 square kilometers), is lowered 1 meter every fourteen or fifteen years, it is calculated that the amount of water annually evaporated must be 1,300,000,000 cubic meters, if none is lost underground. Under the influence of this rapid evaporation the southern part of the lake is gradually being transformed into a deposit of salt, as is also the case with the Caspian Sea, an already dry climate is becoming drier.

1887.

Chabaneix, J. B.

Mémoire sur l'évaporation du sol. Bul. mét. Hérault, 1887.

Continued from 1886.

Davis, W. M.

Water vapor and radiation. Amer. met. jour., 1887, **3**:443–4.

Discusses relation between size and speed of evaporation of water particles floating in the air.

de Touchimbert.

Observations météorologique faites à Poitiers en octobre et novembre, 1886. Ann. soc. mét., 1887, **35**:46.

The evaporation for October was 33 millimeters, for November, 26 millimeters.

Denza, P. Francesco.

Meteorologia Elementare di Roberto H. Scott. (Translation). Milan. 1887.

See Scott, 1887.

Harreaux.

Observations hydrométriques de la Beauce. Ann. soc. mét., 1887, **35**:242–7.

Compares the rates of evaporation from various surfaces under different exposures. Observations for the first three years showed an excess of evaporation equal to the cube of

the rainfall for the same period; in 1876 rainfall and evaporation were equal; in the following years the rainfall exceeded the evaporation, and the levels of wells and streams rose accordingly. (See Harreaux et Gruget, 1886.)

Hauvel, Charles.

Du rôle de la vapeur d'eau dans l'atmosphère. Ann. soc. mét., 1887, **35**:6-7, 9-15.

Study of evaporation as influenced by the "atmospheric tide."

Hépites, S. C.

Evaporation de l'eau. Ann. inst. mét., Roumania, 1887, **3**:124–7.

Daily records of evaporation by Wild's recording evaporometer show two maxima for the year, 3.3 millimeters on May 21 and 3.1 millimeters on September 24. The total annual evaporation was 325.5 millimeters. Other tables show the monthly, seasonal, diurnal, and nocturnal rates. The ratio of the nocturnal to the diurnal rate was 3.53 in 1886 and 3.41 in 1887.

Klein, Hermann J.

Allgemeine Witterungskunde. Leipsic, Vienna, and Prague. 1887. p. 78–80.

General discussion of the laws and the methods of measuring evaporation.

Legras.

Sur un évaporomètre à température regulier. (Résumé par M. Teisserenc de Bort). Ann. soc. mét. 1887, **35**:241–2.

This atmometer is similar to the rain gages issued by the royal Belgian observatory to its meteorological stations It consists of an evaporating dish set into a much larger vessel, also containg water, and designed to reproduce the temperature and hygrometric conditions of a natural stream. Gives the evaporation for May, June, July, October, and November, 1886, as 59.6, 34.2, 34 7, 28.3, and 21.8 millimeters, respectively.

Milani, Gustavo.

Meteorologia popolare. Florence. 1887. p. 90–2.

Short discussion of the process and importance of evaporation.

Mohn, H.

Grundzüge der Meteorologie. Berlin. 1887. 4th ed.

See Mohn, 1875.

Murray, John

Rainfall and evaporation on the land surfaces of the globe. Abstracts in Scot. geog. mag., 1887, **3**:65–77; Met. Zeits., 1887, **4**:63; Forsch. Geb. Agr. Phys., 1888, **10**:457–9.

Evaporation is computed from the run-off and rainfall in different latitudes of the earth's surface, as follows:

Latitude.	Evaporation.	Rainfall.
°	*Mm.*	*Mm.*
50–60 N.	365	555
40–50 N.	510	745
30–40 N.	835	955
20–30 N.	805	940
10–20 N.	885	1,430
10 N.–10 S.	1,375	1,775
20–40 S.	951	1,225
Mean...	965	1,240

These are amounts of evaporation as related to temperature, humidity, and rainfall, while rainfall does not enter as a factor in the record of an evaporometer which shows only what would evaporate with a constant water supply. Estimates that not less than 87,000 cubic kilometers of water evaporate annually from the land surface of the globe.

Peek, Cuthbert E.

Evaporation experiments at Rousden Observatory, Devon, England. Amer. met. jour., 1887, **4**:2–3. Abstract in Quart. jour. roy. met. soc., 1887, **13**:242–3.

The evaporation from soil with turf and from water was measured by means of two similar tanks, 24 x 24 x 15 inches, freely exposed to the air, but protected from the sun's rays by a louvred wooden screen. The total annual evaporation from the soil was 24.79 inches, and from the water 22.81 inches.

Ritter, Charles.

Actions élémentaires dont dépend la croissance des nebules et des hydrométéorites. Ann. soc. mét., 1887, **35**:361–432.

History of earlier views of the formation of atmospheric vapor and discussion of the same from the modern point of view.

Scott, R[obert] H.
Elementary Meteorology. London. 1887. 4th ed. p. 95–103. (Translated by P. F. Denza, 1887. q. v.)

The process, effects, and importance of evaporation are discussed. The rainfall and evaporation on the earth's surface are believed to nearly balance each other.

Symons, G. J.
The Camden Square evaporation experiments. Brit. rainf., 1887, (—):38–9.

Results of measurements at the tank at Camden Square for 1887 and to June, 1888.

Warington, R.
A contribution to the study of well waters. Jour. chem. soc., 1887, **51**:52.

Considers the effect of vegetation in increasing evaporation from the soil.

Woeikof, Alexander.
Klimate der Erde. Jena. 1887. 2 vols.

Estimates annual evaporation from the Caspian Sea as 1090 millimeters. (Vol. 2, p. 265.)

Wollny, E.
Forstlich-meteorologische Beobachtungen. Forsch. Geb. Agr. Phys., 1887, **10**:415–46. Abstracts in Exp. sta. rec., 1895, **6**:197–9; Met. Zeits., 1896, **13**:362–4; also by Abbe, 1895.

An investigation of the rates of evaporation from different soil mulches. Conclusions: (1) The soil evaporates more water than the various mulches. (2) Of all the mulches experimented with, moss evaporates most, then follow oak leaves, beech leaves, fir and pine needles, with but small differences. (3) The thinner the mulch the greater the evaporation. (Continued in 1890.)

1888.

Abbe, Cleveland.
Treatise on meteorological apparatus and methods. Ann. Rpt. Chief Signal Officer for 1887, Pt. 2 (App. 46). Washington. 1888.

Discusses methods of measuring evaporation and of the temperature and rate of the same in connection with the hygrometric conditions of the air. Reviews work on vapor pressure and latent heat of vaporization by Ivory, Apjohn, Regnault, Glaisher, Kämtz, Wüllner, Stefan, Maxwell, Chistoni, Doyére, Angot, Sworykin, Pernter, and Ferrel. The observations by Fitzgerald and the formula derived by him are presented in detail.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. met. Hérault, 1888.

Continued from 1886 and 1887.

Greeley, A. W.
American Weather. New York. 1888. 8vo.

General discussion (p. 45–48) of the various classes of evaporometers.

Hann, J.
Beobachtungen über Verdunstung in der Kolonie New South Wales. Met. Zeits, 1888, **5**:323.

Summarizes the results of observations of evaporation in New South Wales made by H. C. Russell in 1885. (See Symons, 1890.)

Müller-Erzbach, W.
Die Bestimmung der Durchschnittstemperatur durch das Gewicht von verdampfter Flüssigkeit. Met. Zeits., 1888, **5**:453–9.

Determines the average temperature of the air by measuring the loss in weight through evaporation of various liquids. The results agree closely with the means of thermometer readings.

Russell, T[homas].
Depth of evaporation in the United States. Mo. weather rev., 1888, **16**:235–9.

The evaporation from the Piche evaporometer was compared with that from a free water surface in a small dish, both dish and Piche being exposed in the standard louvred shelter of that date. The depth of evaporation recorded by the Piche and the average wind velocity at 19 different stations during June to September, 1888, are tabulated. Also determines the relative amounts lost by evaporation from stationary and whirling Piche for velocities of 10, 15, 20, 25, and 30 miles per hour. The rate of evaporation at Signal Service stations is then computed from the means of the tridaily readings of the wet-bulb and dew-point for the period December, 1887, to January, 1888, inclusive, using the following formula (no wind term is used because of the shelter exposure):

$$30\left(\frac{Ap_w+B(p_w-p_d)}{b}\right),$$

in which p_w=the vapor pressure for the mean monthly temperature of the wet-bulb thermometer, p_d=vapor pressure for the monthly mean dew-point, b=mean barometric pressure, A=1.96, and B=43.9. He compares these computed values with those observed at the Boston waterworks by Fitzgerald; and by means of them constructs a chart of lines of equal annual depth of evaporation at the U. S. Signal Service stations for the period July, 1887, to June, 1888.

Symons, G. J.

The Camden Square evaporation experiments. Brit. rainf., 1888, (—): 42–3.

Tables of evaporation from the large tank at Camden Square from July, 1888, to June, 1889, inclusive.

1889.

Campidoglio, R. Osservatorio del.

Osservazioni meteorologiche del R. Osservatorio del Campidoglio. Atti r. accad. Lincei, 1889, **5**: (4).

The daily evaporation in millimeters and the monthly totals from January to July, 1889, show variations from 54.33 millimeters in February to 149.40 millimeters in July.

Carpenter, L. G.

Evaporation from tanks placed in the ground and also from tanks floating in the water. Colo. exp. sta., 2d Ann. Rpt., 1889, p. 49–76. Abstract in Exp. sta. rec., 1890, **2**:394.

A table presents the monthly evaporation for the years 1887–9 at Fort Collins, Colo., from tanks 3 by 3 by 3 feet and also from smaller tanks to determine the influence of size and material on evaporation. The evaporation computed from the following expression differed only slightly from the observed amount: Evaporation in inches for 12 hours = $0.1934\ (T-t)(1+0.005\ w)$, in which T is the vapor pressure at the temperature of the water surface, t the vapor pressure of the air, and w the velocity of the wind in miles per 12 hours. For a whole day the formula becomes, $E=0.3868\ (T-t)(1+0.0025\ w)$. Fitzgerald's formula is quoted: E (24 hours) $=0.3984\ (T-t)(1+0.0208\ w)$. The close agreement of these coefficients, derived from investigations carried on under as different circumstances as these, strengthens confidence in either formula, and makes it probable that the true value of the coefficient is not far from 0.39 or 0.40. (See Bigelow, 1907.)

Davis, Walter G.

Ligeros apuntes sobre el clima de la República Argentina. Buenos Aires. 1889. p. 238–40.

Tables of evaporation from water in sun and shade, for the years 1886–1888, inclusive, show an annual average of 2292.7 millimeters in the sun and 1169.6 millimeters in the shade. Comparative experiments on evaporation from a copper dish, a glass dish, and a Wild balance, gave in the sun 1320.7 millimeters for the first, 1088.5 millimeters for the second, and 1252.2 millimeters for the last; in the shade 648.8 millimeters for the first, and 624.1 millimeters for the last.

Demangeon, A.

Climatologie d'Épinal (Vosges). Résumé général pour 10 ans, de 1872 à 1881, des observations météorologiques faites à Épinal. Épinal. 1884. 2ième. tirage, 1889.

This lithographed sheet, 10 by 16 inches, presents a table of monthly and annual means of all the meteorological elements, including observations with a psychrometer and a Piche evaporometer, extracted from the "Résumé général detaillé" published by the same author. The mean monthly and annual rainfall and vapor pressures at Épinal for the period 1872–81 are shown in the following table.

The evaporation is here omitted since the table gives no denomination for its figures.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Rainf..	119.2	70.0	75.1	75.0	72.4	89.9	108.6	94.9	78.8	98.9	82.9	68.4	964.0
Vap. pr	4.83	5.19	5.86	6.45	7.52	10.52	12.09	11.75	9.56	7.33	5.84	4.94	7.68

Grossmann. [L.]

Beiträge zur Geschichte und Theorie des Psychrometers. Met. Zeits., 1889, **6**:121–30, 164–76.

Discusses the history and theory of the psychrometer.

Seyfert, T.

Der Einfluss des Bedeckens und des Mischens der Moorboden mit Sand auf seine Verdunstungs- und Temperaturverhältnisse. Mitt. z. Förderung der Moorkultur, 1889, Nos. 17, 18: 205–23; Centbl. Agr. Chem., 1889, (—):678–80. Abstract in Forsch. Geb. Agr. Phys., 1880, **13**:63–4.

Experiments in evaporation from natural moor soil, from the same with sand mixed into the surface layer, and from the same with sand on top but not mixed in, for the period June to October, gave amounts in the proportion, 100:38:20. The effect of a surface layer of sand in retarding evaporation is clearly shown.

Symon, G. J.

On the amount of evaporation. Brit. rainf., 1889, (—):18–43.

A complete résumé of all previous reports of evaporation published in "British Rainfall" from 1867 to 1887, together with descriptions and drawings of the various instruments used at Strathfield Turgiss. Tables of daily evaporation at Camden Square from July, 1889 to June, 1890, and the totals and maxima for each month and year from 1885–1890 are given.

Tacchini, P.

Temperatura ed evaporazione a Massaua. Atti r. accad. Lincei, 1889, 5 (4):329–30.

Investigations show that evaporation at Massaua is almost twice that at places whose mean temperatures are but half as high.

Place.	Mean annual tempera-ture.	Mean daily evapora-tion.
	°C.	Mm.
Bari	15.7	3.1
Massaua	29.8	7.3
Reggio (Calabria)	17.6	3.6

Voeikov.

See Woeikof.

Waldo, Frank.

Distribution of wind velocities in the United States. Amer. met. jour., 1889, 6:309–10.

Discusses the relation between the distribution of wind velocities and evaporation. Describes Russell's (1886, 1888) experiments in this line.

Woeikof, Alexander.

Der Einfluss einer Schneedecke auf Boden, Klima, und Wetter. Geog. Abh., 1889, 3 (Hft. 3):99.

Although the air above a large extent of snow is usually saturated owing to the continual evaporation from the snow, certain winds are so dry that the evaporation can not always maintain this saturated condition of the air. A greater dryness in the air above snow may also result in decreased evaporation due to the lower temperature of the snow compared that of the air.

1890.

Abbe, Cleveland.

Preparatory studies for deductive methods in storm and weather predictions. Ann. Rpt. Chief Signal Officer for 1889. Washington. 1890. App. 15, p. 117–21.

Discusses the various factors influencing the rate of evaporation. For meteorological purposes evaporation from a free water surface, or preferably from moistened cloth or paper, as in the ordinary psychrometer or in the Piche atmometer, is considered a sufficient indication of the evaporating power of the air. Presents the conclusions reached by Tate; the formulas derived by Weilenmann, Stelling, and Fitzgerald; and Russell's comparisons of evaporation with changes in wind velocity.

Battelli, Angelo.

Sull' evaporation dell' acqua e del terreno umido. Nuovo cimento, 1890, 28(3):247–56. Abstract in Naturw. Runds., 1891, 6:270; Ann. uffic. cent. met. Ital., 9:—; Met. Zeits., 1891, 8:394.

Comparative measurements of evaporation, both in sun and shade, from a free water surface and from soil saturated with water, at Chieri (Turin). Also observed a Piche atmometer, a psychrometer, and an anemometer. (See Battelli, 1892.)

Brückner, Eduard.

Verdunstung einer Schneedecke. Met. Zeits., 1890, 7:150–2.

Review of Voeikov, 1889 and 1890. According to Brückner condensation ordinarily occurs on snow, rather than evaporation from it.

Colin, R. P. E.

Observations météorologiques faites à Tananarive. Obs. roy. de Madagascar. Tananarive. 1890. 2 vols. 8vo. Review in Symons's met. mag., 1892, 27:38–40.

His evaporator consists of a zinc tank, 40×40×2.5 inches, inclosed in a wooden box. A table gives the evaporation for the first ten days in February, 1890.

Ekholm, Nils.

Zur Frage über die Verdunstung einer Schneelage. Met. Zeits., 1890, **7**:224–6. Notice in Forsch. Geb. Agr. Phys., 1890, **13**:475.

Discusses the question raised by Voeikov (1890), who declared that snow will evaporate when the temperature of the air is below zero.

Houdaille, F.

Mesure de l'évaporation diurne; description d'un évaporomètre enregistreur. Bul. mét. Hérault, 1890. See Houdaille, 1892.

Conclusions: (1) Daily evaporation as measured by the Piche atmometer is very irregular as compared with that from an evaporating surface more naturally exposed to the action of the wind and nearer the temperature of the air. (2) A continuous record of the rate of evaporation is important for meteorology and for various industries. (3) Describes a recording "evaporometer," which employs the registering mechanism of the Richard thermograph. (4) This rate is always much higher in the daytime than at night, generally at least three times higher. (5) The maxima are determined by the predominance of one of the three factors, temperature, relative humidity, and wind velocity.

Specifies objections to the Piche atmometer. Describes his own atmometer, which consists of an evaporating surface of blotting paper clamped on a brass plate connected with a graduated Mariotte's tube. An opening, 2 mm. in diameter, in the brass plate allows the liquid supplied from the tube to keep the paper constantly soaked.

Moulan, T.-C.

Quantités d'eau évaporées ou absorbées par la végétation dans la bassin de la Gileppe. Ciel et terre, 1890, **11**:328.

Approximate estimate of the water absorbed or evaporated by vegetation.

Russell, Thomas.

Evaporation. Mo. Weather Rev., 1890, **18**:290.

Table 1 shows the depth of monthly evaporation for 1888–9, as measured in a pan and by a Piche atmometer, at Sweetwater Dam, San Diego County, Cal. Table 2 shows the depths of evaporation observed at a number of stations in 1888–90 with Piche atmometers. Tables 3 and 4 show the depths evaporated from pans at stations other than those where the Piche had been used.

Symons, G. J.

On the amount of evaporation. Brit. rainf., 1890, (—):17–31.

Deals in detail with the work of Dines, 1870; Evans at Nash Mills, Hertfordshire (see Greaves, 1876); Greaves, 1876; Lawes at Rothamsted; S. H. Miller at Wisbech, 1878; Peek at Rousdon Observatory, near Lyme Regis, Devon; and Russell at Sydney, N. S. W. Symons assumes that at Sydney a facsimile of the Strathfield Turgiss tanks would lose about 30 inches a year.

van Bebber, W. J.

Lehrbuch der Meteorologie. Stuttgart. 1890. p. 103–9.

General discussion of the process of evaporation, with a description of the Piche atmometer. Results of Eser, Ebermayer, and Stelling are reviewed.

Woeikof, A.

Verdunstung einer Schneelage. Met. Zeits., 1890, **7**:38–9.

Points out that evaporation will take place from the surface of snow as long as the air temperature is below zero. (See Brückner, 1890.)

Wollny, E.

Forstlich-meteorologische Beobachtungen. (Zweite Mitteilung.) Forsch. Geb. Agr. Phys., 1890, **13**:134–84.

Continued from 1887. (See Wollny, 1895, for summary.)

1891.

Allen, H. N.

See Brace, de W. B., and H. N. Allen.

Brace, de W. B., and H. N. Allen.

Meteorological observations for 1890. Nebr. exp. sta. bul., 1891, **4** (no. 27):33–72; Exp. sta. rec., 1891, **3**:29.

Gives the results of observations with 6 Piche evaporometers from June to October, suspended at elevations of 22, 40, 60, 80, and 100 feet.

[Bartet.]

Influence de la futaie de hêtre sur les pluies, l'évaporation et la température de l'air. Ciel et terre, 1891–2, **12**:313–9.

Quotes observations near Nancy by Mathieu in 1867–77. In discussing the influence of a beech forest on rainfall, evaporation, and temperature at Bellefontaine from 1878–88 Bartet ound the following data:

	In woods.	In open.
Annual evaporation (millimeters)	146.4	472.1
Annual rainfall (millimeters)	722.8	852.2
Evaporation as per cent of rain	20%	55%
Ratio of evaporation	1	3.22

The general results at Nancy and Bellefontaine are in mutual accord.

De Heen, P.

Recherches sur la vitesse d'évaporation des liquides pris au-dessous de la température d'ébullition. Bul. acad. sci. de Belgique, 1891, **21**(3):11–25, 214–9, 798–810. Review in Ciel et terre, 1891, **12**: 49–51. Abstract, Met. Zeits., 1891, **8**:351.

Concludes (1) The rate of evaporation increases at first rapidly with the wind velocity, but with higher velocities the increase is more gradual. (2) For any wind velocity evaporation is directly proportional to the vapor pressure. (3) Evaporation is proportional to the molecular weight × vapor pressure.

Further experiments show that a current of saturated air is capable of raising molecules from the surface of the water. A formula is derived for expressing the rate of evaporation: $v = A\ F\,(100 - 0.88 + V^{\frac{1}{2}})$ where $A =$ a constant, $F =$ the vapor pressure at the temperature of the liquid, and $V=$ wind velocity. Observes that all evaporometers acting by imbibition must furnish too small results since the soaked surface is cooled by the evaporation. This influence is barely perceptible at the free surface of a liquid, as convection tends to counteract it.

Greely, A. W.

Irrigation and water storage in the arid regions. (A report on the climatology of the arid regions of the United States with reference to irrigation.) 51st Cong., 2d Sess., House of Rep., Ex. Doc. No. 287. Washington. 1891.

A compilation of data on rainfall and evaporation in the various arid regions of the world, with particular reference to the extensive arid regions of the United States. Appendices contain curves of precipitation, evaporation, amount of sunshine, and normal temperature and weight of aqueous vapor, also tables and charts for Colorado, New Mexico, Arizona, Utah, Nevada, and California. "These curves are composite ones, made up from selected stations, and therefore fairly represent evaporation conditions over the States or sections to which they pertain."

Hann, J.

Beobachtungen über Verdunstung zu Strathfield Turgiss, 1870–1883. Met. Zeits., 1891, **8**:118–9.

Describes methods of observing evaporation at Strathfield Turgiss and Camden Square, London, England, and compares the results with the evaporation measured by Tacchini in southern France and by de Lesseps at the Suez Canal.

[Royal Meteorological Society.]

Exhibition of rain and evaporation gages. Amer. met. jour., 1891, **7**:561-2.

The evaporation gages shown at the Royal Meteorological Society's 12th Annual Exhibition of Instruments included several instruments employed for measuring the evaporation from a free surface of water, and others for use with growing plants.

Symons, G. J., John W. Tripe, and William Marriott.

Twelfth Annual Exhibition of Instruments by the Royal Meteorological Society, held March 3–19, 1891. Quart. jour. roy. met. soc., 1891, **17**:180–92.

Describes most of the instruments exhibited, notably the evaporometers designed by Babington, Lamont, Wild, de la Rue, Piche, Richard, and a collection of instruments exhibited by Symons. An evaporometer designed for use with growing plants is also described (p. 187, ¶ 59.)

Symons, G. J.

On the evaporation from a water surface at Camden Square, London. Brit. rainf., 1891, (—):24–5.

Gives tables of the daily evaporation from the standard tank from July, 1891, to June, 1892; also tables of the monthly and annual totals and maxima for 1885 to 1892.

Ule, Willi.

Zur Beurtheilung der Evaporationskraft eines Klimas. Met. Zeits., 1891, **8**:91–6.

Investigations with a Wild evaporometer lead to a formula employing the psychrometer differences and the wind velocity, viz: $v{=}A\,\Sigma(t{-}t')\,w$, where v=the rate of evaporation,

A=a constant, t and t'=the psychrometer temperatures. The value of A varies considerably with the season.

1892.

Battelli, Angelo.

Comparison de l'évaporation d'une surface d'eau et d'une surface de terre humide. Abstract in L'atmosphère, Octobre, 1892, (—):145–148; Ciel et terre, 1892–3, 13:436.

From the experiments detailed in Batelli, 1890, he concludes: When the temperature of the air is rising, evaporation from saturated soil is in general, greater than from a surface of still water; when the temperature is decreasing, evaporation from the soil diminishes more rapidly than that from water. The evaporation from a free water surface increases more rapidly with the velocity of the wind than that from moist soil. The higher the relative humidity the greater is the proportion of water evaporated from saturated soil in comparison to that evaporated from still water. Evaporation from water in the sun is greater than that in the shade, not only during the day but also during the following night.

Brace, de W. B.

Mean relative evaporation at six different elevations. Nebraska exp. sta. bul., 1892, No. 20: 215–51. Abstract in Exp. sta. rec., 1892, 3:799.

Increase in evaporation is shown with increase in altitude. Continuation of his experiments of 1891.

Carpenter, L. G.

Irrigation engineering. Colorado exp. sta., ann. rpt., 1891:45–57. 1892. Abstract in Exp. sta. rec., 1892, 4:368–9.

A table shows comparative rates of evaporation from water in tanks placed in the ground at Fort Collins, Divide, and Rockyford, Colo., and from tanks floating in a canal and a lake.

King, F. H.

Investigations relating to soil moisture. Wisconsin exp. sta., ann. rpt., 1891:100–34. Abstract in Exp. sta. rec., 1892, 4:122–9.

Experiments show that spring plowing checks the evaporation of soil water. The mean daily rate of evaporation from cultivated soil was 0.665 lbs., and from uncultivated soil 0.808 lbs. per sq. foot.

Houdaille, F.

Marche diurne de l'évaporation à Montpellier, 1891–2. Bul. mét. Hérault, 1892, (—):59–78. Review in Met. Zeits., 1893, 10:431–2.

The curve of a self-recording evaporometer running for 409 days, during the years 1891–2, shows three distinct periods, from midnight to sunrise, from sunrise to sunset, and from sunset to midnight. These periods correspond to equally distinct periods in the rate of evaporation from soil and from plants. The maxima and minima for these periods show interesting variations. The average ratio between daily and nocturnal evaporation is 3.82, varying from 6 90 in August to 1.63 in December. Gives a résumé of the experiments by Hépites, 1887. Diagrams compare evaporation with relative humidity, temperature, and wind velocity.

Houdaille, F.

Recherches expérimentales sur l'influence de la vitesse du vent, de la radiation solaire, et de l'état électrique de l'air dans le phénomène de l'évaporation. Ann. école nat. agr., Montpellier, 1892, 6:197–247.

An investigation of the influence of the velocity of the wind upon evaporation disclosed the following facts: (1) The increase in the rate of evaporation with air movement is very rapid for low velocities, but at 4 meters per second and higher it becomes almost proportional to the wind velocity. (2) The increase of the rate of evaporation is proportional to the increase in wind velocity independently of the difference $(F-f)$, the difference between the vapor tension at the surface of the liquid and that of the air. (3) The relation of the evaporation from a surface of 13 sq. cm. to the air current and to $(F-f)$ is given by the formula,

$$P=1.475\,(F-f)+0.725\,[(F-f)^2+10\,(F-f)]^{\frac{1}{2}}.\,[V^2+17\,V]^{\frac{1}{2}}.$$

(4) When, under the action of the wind, the evaporating surface cools considerably, the rate of evaporation should rather be compared to the factor $(F'-f)$, in which F' is the vapor pressure at the temperature t' of the wet-bulb. (5) The ratio between the rates of evaporation from different surfaces remains almost constant and independent of the wind velocity.

A study of the influence of solar radiation showed (1) that the increase of evaporation due to solar radiation is almost proportional to the intensity of the latter whatever may be the initial value of the evaporation, as measured in shade and in quiet air. (2) The coefficient of the utilization of solar heat in vaporization varies between very wide limits according to the temperature, humidity of the air, and the intensity of insolation. (3) A high electric tension causes a rather rapid increase in the rate of evaporation.

Houdaille, F.

Recherches expérimentales sur le phénomène de l'évaporation. L'atmosphère, August, 1892, (—):101–5.

Latham, Baldwin.

Presidential Address to the Royal Meteorological Society. Quart. jour. roy. met. soc., 1892, 18:53–67. Abstract in Symons's met. mag., 1892, 29:10–11.

Discusses the laws and conditions governing evaporation. Describes experiments showing the influence of capillary action in increasing the evaporating surface, and thus the amount of evaporation. A diagram compares evaporation, differences in vapor pressure, temperatures of air, water, and dew-point. Latham's evaporometer forms the frontispiece to Brit. rainf., 1897.

Müller, P. A.

Ueber die Frage der Verdunstung der Schneedecke. St. Petersburg. 1892. 47p. 4to. From Repert. f. Met., 14 : No. 4. Abstract in Ciel et terre, 1893, 14:192; Met. Zeits., 1892, 9:(80).

In 27 per cent of the hourly observations condensation took place at the surface of the snow, while evaporation occurred in the remaining 73 per cent.

Paris, Observatoire de la Tour Saint Jacques.

Monthly meteorological tables for 1892. L'atmosphère, 1892.

These tables include daily observations of a Piche evaporometer and of a self-recording instrument.

Schubert, J.

Das Klima von Eberswalde nach 15-jährigen Beobachtungen, 1876–1890. Met. Zeits., 1892, 9:233–5.

The average monthly evaporation varies from 7.5 mm. in December to 62.4 mm. in June The annual average is 405.5 mm.

Symons, G. J.

Evaporation. Brit. rainf., 1902, (—):15–23.

Evaporation results are quoted from the Massachusetts State Board of Health Report on Water Supply and Sewage for 1890. Compares the evaporation at Lawrence, Mass., with that at Philadelphia, Pa., at Otterbourne, Hants, at Strathfield Turgiss, and Camden Square, London, Eng.

1893.

Hann, J.

Houdaille's Untersuchungen über den täglichen Gang der Verdunstung zu Montpellier. Met. Zeits., 1893, 10:431-2.

Review of Houdaille, 1892, 1st title.

Hubbard, Gardiner G.

Relations of air and water to temperature and life. Nat. geog. mag., 1893, 5:112–4.

Scattered facts concerning evaporation are cited.

Kerner, Fritz von.

Korrespondirende Berggipfel and Thalbeobachtungen der Temperatur, Feuchtigkeit und Verdunstung. Met. Zeits., 1898, 10:269.

An increase in the amount of evaporation from 0.6 millimeter at 1,215 meters altitude, to 0.9 millimeters at 3,274 meters, is attributed to the decrease in the air pressure since there was no wind.

Piche, A.

Le déperditomètre. Paris. 1893. 4 p. 8vo. From Compt. rend. assoc. franç., Congrès de Pau, 1892.

Diagram and description of an instrument to indicate "sensible temperatures."

Symons, G. J.

Experiments on evaporation at Southampton Waterworks, and at Camden Square. Brit. rainf., 1893, (—):23–6.

Presents the usual records for the large tanks.

van Bebber, W. J.

Meteorologie. Leipsic. 1893.

A general survey on p. 133–5 of the existing knowledge regarding evaporation from water and soil surfaces, and from plants.

Waldo, Frank.

Modern Meteorology. London. 1893. 8vo. p. 149–53, 205–7, 438–40.

Discusses the best methods for investigating evaporation; describes the Piche and Wild evaporometers, and gives numerous statistics of evaporation from water, soils, plants, etc. Discusses the influences of light and temperature and summarizes Wollny's experiments in soil moisture and evaporation.

1894.

Abbe, Cleveland.

Humidity. Mo. weather rev., 1894, 22:407, 453, 496.

Fitzgerald's (1886) formula for determining average vapor pressure is presented. The evaporometer is spoken of as an "integrating hygrometer."

Britzke, O.

Ueber den jährlichen Gang der Verdunstung in Russland. St. Petersburg. 1894. 54 p. 4to. Repert. f. Met., 17, No. 10. Review Met. Zeits., 1895, 12:(76)-(77).

Tables of temperatures, relative humidity, wind velocity, evaporation and the relation between the rainfall and evaporation. The observations have considerable value, according to Kassner, owing to the fact that they were made at so many different stations with similar apparatus, the Wild weighing evaporometer similarly exposed in a Wild thermometer shelter, and for long periods of time.

King, F. H.

Studies relating to ground water and soil moisture. Wisconsin exp. sta. rpt. for 1893, p. 167-200. 1894. Abstract in Exp. sta. rec., 1896, 7:565-7.

It is stated that annual evaporation from manured soil exceeded that from unmanured by 108.5 tons per acre. In two experiments with tubes of sand, one wet with distilled water, the other with a solution of potassium nitrate, capillary ascent and evaporation from the surface was shown to be 22.84 per cent greater in the presence of the potassium nitrate.

Moore, John William.

Meteorology. London. 1894. p. 181-5.

Various methods of observing evaporation are described.

Ruvarac.

Ergebnisse der ombrometrischen Beobachtungen in Böhmen für 1893. Technisches Bureau des Landesculturrathes. Prag. 1894.

See Ruvarac, 1895, and Richter, 1895, for results.

Symons, G. J., and H. Sowerby Wallis.

Experiments on evaporation at Southampton Waterworks, (Otterbourne, Hants), and at Camden Square. Brit. rainf., 1894, (—): 21-4.

The two similar tanks show an annual rate of 19.5 inches at Otterbourne, and 14.5 inches at Camden Square, London.

Todd, Charles.

Meteorological work in Australia, a review. n. p. 1894. 25 p. 8vo. (Reprinted from Rpt. Australasian assoc. adv. sci., 1893.) Summary in Symons's met. mag., 1895, 30:44-5; Met. Zeits., 1895, 12:36-7.

Gives table of mean evaporation at Adelaide for 23 years, and at Alice Springs for 1890-2. The annual average at Adelaide is 55.53 inches; at Alice Springs, 98.55 inches in 1891, and 100.35 inches in 1892. The average rainfall at Adelaide for 54 years is 21.08 inches; at Alice Springs for 19 years, 11.25 inches. (See Todd, Chas., 1879.)

Tomlinson, S.

Rainfall and evaporation observations at the Bombay Waterworks. Quart. jour. roy. met. soc., 1894, 20:63-70.

Gives temperature, relative humidity, rainfall, etc., at Coloba Observatory, the evaporation at the Bhandarwada Filters and elsewhere. Also the approximate average evaporation that may be expected monthly from a water surface in the neighborhood of Bombay, showing the highest rates in March, April, and May, and the lowest in July, August, and September. The annual total from a surface of 1 square foot is 85.5 inches, from a reservoir of 10,000 square feet, 76.0 inches, and from a lake of 300 to 3,000 acres, 62.3 inches.

Vermeule, C[ornelius] C[larkson].

Report on the water supply, water power, the flow of streams, and attendant phenomena. Final Rept., State Geologist of New Jersey, Vol. III. Trenton. 1894.

Formulas for evaporation are developed from the values of the annual rainfall and the mean annual temperature, but in most cases the computed values fail to agree with those obtained by observation. Abstracted by Rafter, 1903.

Wollny, E.

Forstlich-meteorologische Beobachtungen. Dritte Mitteilungen. Forsch. Geb. Agr. Phys., 1894, 17:153-202. Abstract Exp. sta. rec., 1894, (—):—; Met. Zeit., 1896, 13:76-7.

Describes experiments comparing the evaporation from pine trees, birch trees, grass and fallow land with the rainfall. The results of this and previous papers in 1887 and 1890 are summarized in Wollny, 1895. See also Abbe, 1895.

1895.

Abbe, Cleveland.
The meteorological work of the U. S. Signal Service, 1870 to 1891. Rpt. Internat. Meteorol. Cong., Chicago, August, 1893. U. S. Weather Bureau, Bul. 11, pt. II (Apr., 1895), p. 232–285.

Regular observations of evaporation were inaugurated by the Signal Service in 1885, and T. Russell's "investigation of the influence of the wind on the indications of Piche's apparatus and his estimates (Russell, 1888) of the general depth of evaporation throughout the United States, mark out the path that must be pursued by future investigators in this line."

Abbe, Cleveland:
Note by the Editor. Mo. weather rev., 1895, **23**:421–2. Notice in Exp. sta. rec., 1897, **8**:111. Reprinted, Nature, 1896, **54**:283.

Translation of summary of Wollny's (1895) investigations on evaporation.

Bebber, W. J. van.
Hygienische Meteorologie. Stuttgart. 1895.

General discussion on p. 150–2 of the process of evaporation, the factors influencing it, and the Piche evaporometer as a suitable instrument for measuring its amount.

Harrington, Mark W.
Sensible temperatures. Paper read before the American Climatological Association in Washington, 1894. Review in Amer. met. jour., 1895, **12**:93–4.

Points out that the sensible temperature is lowered by the absorption of heat due to evaporation.

Houdaille, F.
Météorologie agricole. Paris. 1895. p. 36–9, 103–4, 124–5.

This publication recounts the results of much of the author's previous work on evaporation, adding nothing new to the conclusions reached in preceding papers.

Krebs, Wilhelm.
Verdunstungsbeobachtungen mit dem Doppelthermometer. Met. Zeits., 1895, **12**:38–9.

The discussion started in this paper regarding the psychrometer as a measure of evaporation, is dealt with at greater length in 1904.

Pague, B. S.
Sensible temperatures, or the effect of heat on the body in California. San Francisco. 1895. Reprinted, Amer. met. jour., 1895, **12**:196–8.

Treats of the well-known fact that the body is cooled by the evaporation of perspiration from the skin.

Penck, Albrecht.
Evaporation in central Europe. Reviewed in Geog. jour., 1895, **5**:583.

Direct measurements of evaporation in Austria and Bavaria since 1821 and in Prussia since 1876 indicate an average yearly evaporation in north Germany of 15.7 inches, decreasing southward to about 11.8 inches. A marked increase is shown in the Hungarian plain, 25.6 inches at Budapest and still more in the southeastern districts. An almost uniform decrease of 60 per cent is observed in forest stations, compared with the open country, while a remarkable increase is noticed in towns. In Vienna the evaporation exceeded that in the immediate neighborhood by 5.9 inches. Classifies the monthly curves of evaporation according to districts. The total aqueous vapor passing into the air over a large area is estimated from the total rainfall and the total calculated discharge by rivers, the difference being taken as the amount of evaporation. From these results he concludes that evaporation is influenced to some extent by the rainfall itself.

Russell, Thomas.
Meteorology, weather, and methods of forecasting. Descriptions of meteorological instruments and river flood predictions in the United States. New York. 1895. 8vo.

On p. 47 describes the Piche atmometer and an experiment showing the effect of various wind velocities on evaporation. On p. 70–1 compares the depth of water evaporated at various stations.

Symons, G. J., and H. Sowerby Wallis.
Percolation experiments at Apsley Mills, Hemel Hempstead. Brit. rainf., 1895, (—):26–35.

The results of percolation experiments at Apsley Mills, conducted by Sir John Evans, are tabulated, according to seasons for the 12 years, 1883–94, as follows:

Rainfall, percolation, and evaporation at Apsley Mills, 1883–94.

	Rain.	Sand, 3 feet.		Sand, 5 feet 2 inches.	
		Percolation.	Evaporation.	Percolation.	Evaporation.
Summer	12.55	3.91	8.64	3.94	8.61
Winter	13.51	12.55	0.96	12.57	0.94
Year	26.06	16.46	9.60	16.51	9.55
		Chalk, 3 feet 3 inches.		Chalk, 5 feet 2 inches.	
Summer		1.83	10.72	1.97	10.58
Winter		10.42	3.09	15.25	3.26
Year		12.75	13.81	12.22	13.84
		Ordinary soil, 3 feet 3 inches.		Ordinary soil, 5 feet 2 inches.	
		Percolation.	Evaporation.	Percolation.	Evaporation.
Summer		1.54	10.01	1.59	10.96
Winter		11.21	3.30	10.97	2.54
Year		12.75	13.31	12.56	13.50

Symons, G. J., and H. Sowerby Wallis.

Experiments at Southampton Waterworks and at Camden Square. Brit. rainf., 1895, (—):36–9.

Evaporation observations at Camden Square from 1885 to 1895 and at Otterbourne from 1892 to 1895 show an annual average for the former place of 14.66 inches, and 20.46 inches for the latter.

Wallis, H. Sowerby.

See Symons and Wallis.

Wollny, E.

Untersuchungen über die Verdunstung. Forsch. Geb. Agr. Phys., 1895, **18**:486–516. Review in Met. Zeits., 1896, **13**:362–4; by Abbe, 1895; Ciel et terre, 1896, **17**:570–1; Centbl. Agr. Chem. (Biedermann), 1897, **26**:74–7.

"Lysimeters" (zinc boxes 400 square centimeters in cross section and 30 centimeters deep), standing in the open with a 15-centimeter layer of soil in them, and weighed every five to nine days, furnished the following results: (1) Soil evaporates less than a free water surface. (2) Sand evaporates least, loam most, while bare turf and humus or vegetable mold are intermediate. (3) Evaporation from soil is increased by a cover of vegetation. (4) Evaporation depends on meteorological conditions and on the quantity of moisture in the soil. (5 and 6) Temperature is the most important factor affecting evaporation, modified by other factors, mainly by the amount of water supplied by the substratum. (7) For evaporation from a free water surface, from saturated soil and from ordinary moist soil whether covered with living plants or not, the important elements to be considered are temperature, relative humidity, cloudiness, direction and velocity of the wind, and the amount of rain. (8) Sometimes a soil covered with plants evaporates more than a free water surface. (9) The amount of water evaporated from a soil covered with plants and not irrigated can not be greater than the quantity received by the soil before or during the period of growth. But swamp lands, lands well irrigated and free water surfaces evaporate, under favorable conditions, a greater quantity of water than corresponds to the precipitation during the same time. (10) The evaporating power of a soil depends on its physical properties. With less permeability, larger capacity for water and greater capillary power, evaporation is more active. (11) Soil with plants evaporates more as the plants are better developed, stand closer together, or have longer period of growth and vice versa.

1896.

Boggs, Edward M.

Arizona weather. Arizona exp. sta. bul., 1896, No. 20.

Evaporation at Tucson, Ariz., was observed by means of a galvanized-iron tank, 6 by 4 by 4 feet, sunk in the ground. The water always stood within *a few inches* of the top, and its level was read by means of a Boyden hook gage reading directly to 0.001 foot, placed in a still well about 10 inches from the tank and connected therewith by a pipe of small diameter. The tank was in a fenced inclosure, fully exposed to the wind. The observations from December, 1891, to June, 1895, showed an annual evaporation of 77.7 inches.

somewhat less than is commonly attributed to this region. The evaporation from a second tank containing growing waterlilies was only 1 per cent less than from the first.

Bühler, A.

Untersuchungen über die Verdunstung des Wassers aus dem Boden. Mitt. Schweiz. Centralanst. forstl. Versuchsw., 1895(?), **4**:315. Reviewed in Met. Zeits., 1896, **13**:(22); Mo. weather rev., 1896, **24**:374; Ciel et terre, 1896, **17**:21–2.

* Experiments were made at Adlisburg from June 27 to September 1, 1894, with evaporation from loamy clay in five metal boxes, 20 centimeters square and 10 centimeters high, one placed level and four on an incline of 30° and facing the four cardinal points of the compass. The following rates were obtained: Horizontal, 100; north exposure, 91; east exposure 87.5; south exposure, 100.5; west exposure, 100.5. The ratios for differently shaded plots were: for unprotected soil, 100; one-fourth covered, 88; one-half covered, 71; three-fourths covered, 62. Evaporation was found to be the most rapid from noon to 3 p. m.

Crosby, D. J.

Temperatures and evaporation in different soils. Michigan exp. sta. bul., No. 125, p. 30–2. Quoted in Exp. sta. rec., 1896, **7**:373–5.

In experiments on evaporation from sand, clay, loam, and muck, it was found that the sand lost water most rapidly; loam, clay, and muck following in the order named. The surface temperature, however, was highest in muck and lowest in sand, but at depths of 3 and 6 inches the sand was the warmer. When the light-colored sand was covered with lamp black and the dark-colored muck with white lime, this order of temperatures was reversed, showing that the color of the surface largely controlled the temperatures below.

Milne, John.

Movements of the earth's crust. Geog. jour., 1896, **7**:229–55.

On p. 242–3 the author discusses the influence of evaporation on the movements of the earth's crust. Applying the figures obtained by Miller, 1878, he shows that " the greatest displacement of a horizontal pendulum ought to be expected when such an instrument was placed on the boundaries of two areas respectively covered with soil and grass. On a fine day the differential evaporation effect on the two sides of the instrument would be equivalent to moving a load of about 2.5 tons per 29 yards square from the ground covered with grass, which is quite sufficient to produce many of the observed effects."

Müller, P. A.

Ueber die Temperatur und Verdunstung der Schneeoberfläche und der Feuchtigkeit in ihre Nähe. Mem. acad. imp. sci., St. Pétersbourg, Phys. Math. Cl., 1896, **5** (8), No. 1. Also St. Petersburg. 1896. 38 p. 4to. Review in Met. Zeits., 1897, **14**: (12).

Discusses observations on the surface temperature of snow, the temperature and relative humidity of the air in its neighborhood, and its evaporation. The author emphasizes the point that condensation occurs when the difference between the dew-point of the air and the temperature of the surface of the snow is positive, evaporation occuring when this difference is negative.

Penck, A[lbrecht].

Untersuchungen über Verdunstung und Abfluss von grösseren Landflächen. Geog. Abh., 1896, **5**:461–508. Review in Met. Zeits., 1897, **14**: (55). Abstract in Geog. jour., 1897, **9**:563–4.

Studies of the monthly variations in the relation between the rainfall, drainage, and evaporation of the river Elbe in Bohemia. The average rainfall for 1888–1890 was 696 millimeters, runoff, 214 millimeters, and evaporation, 482 millimeters, the evaporation factor being 69.2 per cent of the total loss. The average evaporation factor for 1893–4 was 76 per cent. Richter's (1895) similar factor for the latter period is quoted. Evaporation is further arranged according to temperature, rainfall, seasons, etc., and formulas for determining the same are devised.

Phillips, W. F. R.

Sunstroke in California and Arizona. Mo. weather rev., 1896, **24**:454–6.

Quotes Fitzgerald's (1886) formula for calculating evaporation, in connection with an investigation of the evaporation from the human body to prove that, in accordance with statistics, sunstrokes occur as often in localities where the relative humidity is low as where it is high.

Schierbeck, N. P.

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlingar, 1896, No. 1. Copenhagen.

A mathematical treatment of the subject of evaporation. (See Schwalbe, 1902, for his formula.)

Symons, G. J., and H. Sowerby Wallis.

Evaporation. Brit. rainf., 1896, (—):27–31.

Tables give daily evaporation at Camden Square, Middlesex, Isfield Place, Sussex, Otterbourne, Hampshire, and Kennick Reservoir, Devon, from July, 1896, to June, 1897.

Trabert, Wilhelm.
Neue Beobachtungen über die Verdampfungsgeschwindigkeit. Met. Zeits., 1896, **13**:261–3.

The formulas of Dalton, Stefan, and Schierbeck are presented. The author's own formula, a modification of Schierbeck's(1896), is $V=k(1+\alpha t)w^{\frac{1}{2}}(e_o-e)$. Where V=the rate of evaporation, k=a constant, α=1/273, w=the wind velocity, t=the air temperature, e_o= the maximum vapor pressure at the temperature of the water, and e that at the temperature of the air. But $(e_o-e)=(e_o-e_o')(e_o'-e)$, where e_o' is the maximum vapor pressure at the temperature of the wet-bulb. The readings of the wet- and dry-bulb thermometers are believed to offer a better and more practical method of determining evaporation than the direct observation of the loss in weight due to evaporation.

Twigg, R. H.
Evaporation at Kimberley, South Africa., Quart. jour. roy. met. soc., 1896, **22**:166. Review in Met. Zeits., 1896, **13**:279.

The evaporation gage of the Kimberley Waterworks Co. is a wrought-iron tank 4 by 4 by 4 feet, sunk in the ground to within an inch of the top and kept nearly full of water. Daily readings were made with a hook-gage designed by the author which allows readings to 1/1000 inch. A table shows the monthly evaporation from January, 1891, to January, 1895.

1897.

Abbe, Cleveland.
Evaporation at Fort Collins, Colo. Mo. weather rev., 1897, **25**:211.

Summarizes Carpenter's (1889) experiments with evaporation, and quotes his formula.

Alston, Garwood.
Comparison of evaporation results in New South Wales and South Africa. Trans. So. African phil. soc., 1897, **9**:8–19.

A comparison of the results obtained in New South Wales by Russell (1888–1904), and those obtained by the author from a reservoir at Van Wyks Vley shows 41 inches at Lake George, N. S. W., and 66 inches at Van Wyks Vley. At other Australian stations the evaporation varies from 28 to 60.5 inches.

Barnes, Nathan H.
Arizona weather and climate. Arizona exp. sta. bul., 1897, No. 27.

This is, with a few changes and additions, the paper by Boggs, 1896.

Bruyn, H. E., de.
Mededeeling over de betrekking tusschen regenvall, verdamping en waterafooer. The Hague. 1897. 14 p. 4to. Review in Met. Zeits., 1897, **14**:(66).

Canestrini, Eugenio.
Sull' evaporazione del' acqua da superficie acquea, terrosa, ed erbosa. Atti soc. veneto-trentina sci. nat., 1897, **3**(2d. ser.):295–305.

In connection with experiments with evaporation from soils with and without vegetation, references are made to Schübler, 1831, Masure, 1880, Haberlandt, 1877, Risler, 1869–70–71, Hellriegel, 1883, and Wollny, 1895. From the author's own experiments he concludes in general that: (1) a soil constantly saturated evaporates more water in a year than a free water surface; (2) a soil with growing grain evaporates much more than a bare soil.

Davis, Arthur Powell.
Irrigation near Phoenix, Ariz. Water sup. and irr. papers, 1897, No. 2.

On p. 83–5 discusses methods for reducing evaporation from reservoirs in Arizona, and proposes to cover the surface of the water with a film of crude petroleum.

Fortier, Samuel.
Seepage water of northern Utah. Water sup. and irr. papers, 1897, No. 7: 17–24, 26, 43.

The apparatus consisted of a galvanized iron pan 36 by 36 by 10 inches floated in the reservoir. A diagonal bar scale permitted readings of the level to 1/100 inch. Tables of the evaporation at Fort Douglas, near Salt Lake City, Utah, for 1889–93, and at Fort Collins, Colo., 1887–91, are presented together with Russell's (1888) table of evaporation from the Piche atmometer at various localities in the United States. The total annual evaporation from water surfaces in Utah is estimated as from 3 to 6 feet, the evaporation during the dry season (May–August) of this region being equal to that of the other eight months. Gives a table of the relation between the crop harvested and the amount of evaporation. Under Logan river is discussed the relation between the rainfall and evaporation.

Houdaille, F.
Causes de vitesse maxima d'évaporation sous le climat de Montpellier. Ann. école nat. agr., Montpellier, 1897, **9**:286–95. Notice in Exp. sta. rec., 1897, **9**:1032–3.

The ratio of evaporation from the instrument previously described (Houdaille, 1890) to

that from the Piche is given as 1.32. The mean daily evaporation (1875–84) varies between 3.23 millimeters in January and 9.35 millimeters in July. Gives the diurnal evaporation, temperature, humidity, and wind for January to September, 1896. Concludes that the wind is not an important factor in that locality, temperature and humidity being the main factors influencing evaporation there.

Krebs, Wilhelm.
Das Messen der Verdunstungsenergie mit dem Doppelthermometer. Met. Zeits., 1897, **14**:273–6.

Derives a formula for calculating evaporation directly from the readings of the psychrometer. Both Krebs and Ule (1897), claim priority in devising this method.

Latham, B.
Tables of evaporation from a 12-inch floating tank and a 5-inch exposed tank at Croydon, 1888–1897. Brit. rainf., 1897, (—):30–34.

Also gives illustration of Latham's evaporometer.

Madrid, Observatorio de.
Treinta años de observaciones meteorologicas, Madrid, 1860–94. Madrid. 1897.

Tables of the mean daily evaporation, 1860–94, from an exposed dish of water, accompanied by a table showing the lowering of temperature caused by evaporation. The average daily evaporation varies from 1.0 millimeter in January to 9.8 millimeters in July. The cooling effect varies from 1.3° C. to 9.1° C. for the same months. No yearly totals are given.

Pallich, J. von.
Ueber Verdunstung aus einer offen kreisförmigen Becken. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1897, **107**(pt. 2a): 384–410.

Concludes that the ellipsoidal surfaces of equal vapor pressure above an evaporating surface, as mathematically derived by Stefan (1831), have too small an excentricity as compared with curves experimentally derived, and that this difference becomes more pronounced with higher temperatures. In the case studied this eccentricity should be 95 instead of 51 as given by Stefan's equation.

Royal Meteorological Society.
Exhibition of meteorological instruments in use in 1837 and 1897. Quart. jour. roy. met. soc., 1897, **23**:221–36.

On page 234 Pickering's (1898) atmometer is described; also a new Richard self-recording evaporometer. In this new pattern a sheet of blotting paper is kept moist by a wick which draws water from a closed reservoir. A float transmits to the pen the height of the liquid in the reservoir.

Rafter, Geo. W.
Stream flow in relation to forests. American Forestry Association, 1897, 12. Reprinted in Ann. rpt. Fisheries, Game, and Forest Commission for 1896. 1898.

An extensive discussion of the persistence at about the same rate, of the amount of evaporation from any given stream through long periods of time.

Symons, G. J. and H. Sowerby Wallis.
Records of evaporation. Brit. rainf., 1897, (—):28–34.

Gives the evaporation during 1897 at the usual stations, and also Latham's tables for 1888–97.

Ule, Willi.
Messung der Verdunstungsenergie mit dem Doppelthermometer. Met. Zeits., 1897, **14**:382–3.

Claims priority in the employment of the psychrometer to indicate the evaporating power of the air. (See Abbe, 1888, Krebs, 1895, 1897, and Ule, 1891.)

1898.

Abbe, Cleveland.
Evaporation and temperature. Mo. weather rev., 1898, **26**:213–4.

Summary of the work of Carpenter, 1898.

Bedford, Duke of.
See Pickering, S. U., and the Duke of Bedford.

Carpenter, L. C.
The loss of water from reservoirs by seepage and evaporation. Colorado Exp. sta. bul., 1898, No. 45. Abstract in Mo. weather rev., 1898, **26**:213. Abridged in Symons's met. mag., 1898, **33**:116–9.

Evaporation at Fort Collins, Colo., (alt. 4,990 ft.) from 1882-97, as measured by means

of a hook-gage, gave an annual average of 40.94 inches. General discussion of the factors influencing evaporation. Unless the temperature of the water surface is warmer than the dew-point, evaporation can not proceed and condensation may occur. Evaporation from ice was 1.0 to 1.5 inches per month. The nocturnal evaporation, contrary to the general opinion, was almost the same as the diurnal, and these amounts approach equality as the body of water increases in size. Tabulates observations at many localities and altitudes in Colorado and California. He finds that the factors tending to decrease evaporation at high altitudes are lower temperatures, smaller differences between the vapor pressure at water surface temperature and that at the dew-point, and the decreased capacity for moisture of air at lower temperatures. Concludes that, although lessened air pressure and probable increased velocity of the wind at high altitudes favor evaporation, the annual rate is much less than at low altitudes.

Carpenter, L. C.

Losses of evaporation from canals. Records kept for two years on stretches of canals for irrigation purposes. Colo. Exp. sta. bul., 1898, No. 48. Summary in Exp. sta. rec., 1899, **10**:795–6.

Evaporation from canals is believed to be insignificant as compared with seepage, while in the case of reservoirs evaporation is the more important source of loss. The total depth of water lost from canals in the prevailing Colorado soils is estimated at from 1 to 2 feet per day over the whole surface of the canal, being less in clay soils than in sand or gravel.

Carpenter, L. C., and others.

Evaporation at the Colorado station. Colo. Exp. sta. bul., 1898, No. 49. Abstract in Exp. sta. rec., 1899, **10**:1019.

Results similar to those published in first title; repeats his formula published in 1888.

Gravelius, H.

Berichte über den Stand der Niederschlagsforschungen. Zeits. Gewässerk., 1898, **1**:341.

Reviews Heinz, 1898, who compared evaporation as observed at 15 stations in European Russia from 1871–95. A rapid increase in the annual evaporation is indicated in the direction from northwest to southeast: St. Petersburg, 331 millimeters; Vishni Volotshek, 352 millimeters; Moscow, 434 millimeters; Skopin, 572 millimeters; Nikolaiiev (Sara'of), 643 millimeters; Astrakhan, 750 millimeters. The yearly maximum occurred nearly everywhere in July and the minimum in January. Relations between the rainfall and evaporation are pointed out. Attention is drawn to the fact that experiments with evaporation from a grass surface have been conducted at Pavlovsk by means of Rykachev's (1900) atmometer since 1896.

Grunsky, Carl Ewald.

Irrigation near Fresno, Cal. Water sup. and irr. papers, 1898, No. 18:74–8.

Finds the loss of water from canals is less by evaporation than by seepage.

Heinz, E. A.

Ueber Niederschläge, Schneemenge, und Verdunstung in der Flussgebieten des Europäischen Russland. St. Petersburg. 1898. Review in Selsk. Khoz. i Lyesov., 1898, **109**:716–7. Notices in Met. Zeits., 1898, **15**:(77); Exp. sta. rec., 1898, **10**:327

Reviewed by Gravelius, 1898.

Héjas, André.

A zivatarok magyavországon az 1871—töl 1895—ig terjedö megfigyelések Alapján. (Die Gewitter in Ungarn nach den Beobachtungen von den Jahren 1871–95.—Kurzer Auszug des ungarischen Originales.) Budapest. 1898.

The original gives, on p. 50–1, the daily evaporation during March to October, for the years 1890–5, at Budapest. The average daily rate varied between 1.20 millimeters for March and 3.92 millimeters for July.

Maxwell, W.

Evaporation and plant transpiration. Jour. Amer. chem. soc., 1898, **20**:469–83. Reviewed in Exp. sta. rec., 1899, **10**:721–2.

Experiments were conducted at the experiment station at Honolulu, T. H., on the amount of moisture directly evaporated from the soil, and the relative proportion that escapes by transpiration from sugar cane during the different periods of growth. The transpiration from sugar cane growing in a tub was observed for 270 days, together with the outdoor and indoor evaporation of water in small galvanized evaporators, temperature, humidity, direction of wind, etc. The amount evaporated outdoors during this time was 33.480 cubic centimeters, with an average temperature of 75.9° F.; that indoors was only 14.175 cubic centimeters, with a temperature of 79.9° F. The humidity was the same in both cases. The inference is that the wind exerts a greater effect upon the rate of evaporation than the temperature.

Mazelle, E.

Verdunstung des Meerwassers und Süsswassers. Sitsber. k. Akad. Wiss. (Vienna), math.-naturw. Kl., 1898, **107**:(pt. 2). Also reprinted Vienna, 1898. 20p. 8vo. Abstracts in Ciel et terre, 1899, **20**:267–8; Anz. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1898, no. 7, **35**:49–50.

Daily observations from June 1, 1896, to September 30, 1897, at Triest, with two Wild atmometers of similar construction and exposure, one containing fresh water, the other a 3.73 per cent salt solution, showed that the ratio between the results approached nearer unity as the rate of evaporation from the fresh water increased. An equation in which x is the evaporation from the fresh water, and y that from the salt water, shows the following relation: $y = -0.018 + 0.7303x + 0.0561x^2 - 0.0044x^3$. The total amount evaporated from the fresh water was 910.6 millimeters, that from the salt water 750.9 millimeters, the ratio being 100:82.46. Complete tables compare these rates of evaporation with other meteorological factors.

Mohn, H[enryk].

Grundzüge der Meteorologie. Berlin. 1898. (5th ed.)

See Mohn, 1875.

Pickering, S. U., and The Duke of Bedford.

A new form of evaporimeter. Woburn exp. fruit farm rpt. for 1897, p. 168–74. Also quoted in Exp. sta. rec., 1898, **9**:533.

The object of this instrument is to approach as nearly as possible to the conditions governing the leaves of a tree. It consists of a sheet of any absorbent material, held vertically by means of a movable copper frame in a vessel of water fitted with a graduated side tube. The evaporating sheet ends in a tongue which dips into the water and is thus kept moist.

Symons, G. J., and H. Sowerby Wallis.

Records of evaporation. Brit. rainf., 1898, (—):36–44.

Gives the evaporation at seven different stations; describes Miller's sand evaporator, and gives its records for 1879–98. See H. Sowerby Wallis for succeeding records.

Wollny, E.

Untersuchungen über die Verdunstung und das Produktionsvermögen der Kulturpflanzen bei verschiedenem Feuchtigkeitsgehalte der Luft. Forsch. Geb. Agr. Phys., 1898, **20**:528, Also Centbl. Agr. Chem. (Biedermann), 1900, **29**:289–90.

Experiments on the relation between transpiration and plant growth.

1899.

Angot, Alfred.

Traité élémentaire de météorologie. Paris. 1899.

A general discussion of the process and laws of evaporation and various methods of measuring it, occurs on p. 173–5.

Galli, D. Ignazio.

Atmidometro a livello costanto. Atti accad. pont. nuovi Lincei, 1899, **52**:157–8. Also Mem. accad. pont. nuovi Lincei, 1900, **17**:165–82.

This evaporometer consists of two communicating cavities in a solid block of marble, one containing powdered marble, the other closed and filled with water which is drawn by capillarity to the surface of the powdered marble, where it is allowed to evaporate.

Gravelius, H.

Ueber Verdunstung. Zeits. Gewässerk., 1899, **2**:248–52.

The run-off of a region is regarded as a function of the rainfall, evaporation, seepage, and the amount of water used by the vegetation. Describes Rykachev's apparatus (1900) for measuring evaporation from soil.

King, F. H.

Irrigation and drainage. New York. 1899.

The transpiration of plants and the slow rate of evaporation from a dry soil are dealt with on p. 46–54 and 98.

Minssen, Guilherme.

Lyceu Rio Grandense de Agronomia de Pelotas. Contribuiçao para o estuda da Climatologia do Rio Grande do Sul. Observaçiónes meteorologica feitas durante o anno de 1899.

Weekly observations at Pelotas, Brazil (lat. 31° 30′ S.), of evaporation from water, with monthly and yearly totals for 1899; also weekly, monthly, and yearly averages from 1893–9. The results show an antipodal yearly march of evaporation comparable with that of the northern hemisphere. The monthly average during 1893–9 varied from 66.5 millimeters in June to 140.1 in December, the annual average being 1157.7 millimeters.

Raulin, F. V.

Résumé des observations atmidométriques (évaporation) faites dans la Peninsule Ibérique de 1857 à 1890. Ann. soc. mét., 1899. Reprinted Tours. 1899. 20 p. gr. 8vo.

Wallis, H. Sowerby.

Records of evaporation. Brit. rainf., 1899, (—):31–4.

Table of evaporation at Camden Square, London, 1885–99. Evaporation records for 1899 at eight stations, five of which use the standard tank, 6 by 6 by 2 feet, are published, together with a table of the observations at Croydon by Baldwin Latham.

1900.

Brown, H. T., and F. Escombe.

Static diffusion of gases and liquids in relation to the assimilation of carbon and translocation in plants. Phil. trans., 1900, **193**: 283–91. Abstract in Annals of Botany, London, 1900, **14**:537–42.

The rate of diffusion of aqueous vapor through small apertures is controlled by the linear dimensions of the aperture and not by the area; the velocity of flow varies inversely as the diameter of the opening. Critically reviews other work along this line, especially that of Stefan (1873).

Davis, Walter G.

Clima de Córdoba. Ann. ofic. met., 1900, **13**:492–505, 573–97.

This report contains very complete tables of temperatures of evaporation, and of comparative rates of evaporation from six dishes of different size, material, and exposition. The temperature of evaporation was shown to be lower than that of the air, the difference averaging 3.81° C. for the year. The greatest difference was 4.81° in September and the least 2.70° C. in June. The hourly means for 1889–98 are tabulated. The comparative observations were made with (1) two brass dishes 10 centimeters deep, exposing 314 square centimeters surface, one in the thermometer shelter, the other fully exposed to the weather; (2) two Wild balances, whose dishes have a surface of 250 square centimeters and a depth of 45 millimeters at the edge and 30 millimeters in the center, having the same exposure as the metal evaporators; (3) a glass dish exposing 380 square centimeters evaporating surface and 13 centimeters deep exposed near the other evaporators; (4) a square, zinc-lined tank of brick, 80 centimeters deep and exposing a surface of 1 square meter. This tank is buried in the ground so that its water level is at the level of the contiguous soil and about 10 centimeters below the edges of the tank. The water level is read by a micrometer screw. Readings were taken every two hours, night and day, with all the instruments, except the glass dish and the tank which were read only once in 24 hours. The results of all these instruments are compared in detail and a study is made of the influence of the direction and force of the wind upon evaporation. The amounts of evaporation in 2 hours corresponding to increments of 5 kilometers in wind velocity are tabulated separately.

Escombe, F

See Brown, H. T., and F. Escombe.

Exner, Felix M.

Messungen der täglichen Temperaturschwankungen in verschiedenen Tiefen der Wolfgangsees. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1900, **109** (pt. 2a):905–22.

A table of the evaporation accompanies other meteorological data.

Latham, B.

The climatic conditions necessary for the propagation and spread of the plague. Quart. jour. roy. met. soc., 1900, **26**:37–94.

The greatest amount of evaporation or exhalation would take place with the maximum temperature of the ground and the minimum dew-point, and it is shown that the rise and fall of these differences agree in a remarkable manner with the rise and fall of the plague. Taking into consideration the wind and its influence on evaporation, the author used Dr. Pole's formula for calculating evaporation: $E = \frac{T^2 - t^2}{A\,(100 - w)}$, in which T equals the temperature of the ground, t the temperature of the dew-point, and w the wind velocity in miles per hour A equals a coefficient, 80 for Bombay, and E is the evaporation or exhalation in depth per day in inches. Diagrams show curves of the tensional difference agreeing with that of death from plague in Bombay.

Lippincott, Joseph Barlow.

Storage of water on the Gila River, Arizona. Water sup. and irr. papers, 1900, No. 33.

Quotes (p. 32–4) evaporation observations by the U. S. Geological Survey in Arizona and estimates the rate of evaporation from the reservoir at Buttes, Ariz.

Maluschitski.

On the value of evaporometric observations to agricultural practice. Izv. Moscov. selsk. khoz. inst. (Ann. inst. agron. Moscou), 1900, **6**:325–403. Abstract in Exp. sta. rec., 1901, **13**:427.

Studies the evaporation from a free water surface and from soils. For a free water surface Michelson and Wild atmometers were used, and Wild's was found the more reliable. Evaporation from soil was determined by means of large zinc lysimeters. From his own experiments and a survey of the literature the author concludes: "Since the structure of the soil and the state of its surface exert an immense and varied influence on the stored-up humidity, as well as on the evaporation, no correlation can be established between the evaporation from a water surface and that from a cultivated soil, and still less in the case of a soil covered with plants."

Rykachev, M.

New evaporometer for the study of the evaporation from grass and observations with it in 1896 at the Constantine Observatory. Zhur. opuitn. agron. (Russ. Jour. exp. Landw.), 1900, No. 1, **1**:115–7. Abstract in Exp. sta. rec., 1901, **13**:428.

This apparatus consists of three rectangular zinc boxes, the outer one sunk in the ground, the other two fitting tightly into it, one above the other, the upper one containing soil with sod. Excess of rain water percolates into the middle box and maintains a constant degree of humidity in the lower layer of the upper vessel. The amount lost by evaporation is determined by weighing the upper and middle boxes together. The temperatures of the soil and of the water in the lower box were recorded. The indications of this instrument were found to be two or three times greater than those of a Wild atmometer.

Saussure, Horace Bénédicte de.

Versuche über die Hygrometrie. Neuchâtel, 1783. Herausgegeben von A. J. Oettingen. 2 vol. (Ostwald's Klassiker der exakten Wissenschaften, Nos. 116, 119. Leipsic. 1900.)

See Saussure, 1783.

Scott, R. H.

Results of percolation experiments at Rothamsted, September, 1870, to August, 1899. Quart. jour. roy. met. soc., 1900, **26**:139–51.

Table I gives the annual amount of rain, and of percolation as measured at three depths, 20, 40, and 60 inches, in gages similar to those described by Lawes, Gilbert, and Warington, (1881). Table II gives the monthly average for the entire period, and also the same grouped into half-yearly periods, September to February and March to August. Table III gives the actual monthly measurements for each year of the series. The evaporation may be obtained by subtracting the amount of percolation from the amount of rain.

Wallis, H. Sowerby, and Hugh Robert Mill.

Records of evaporation. Brit. rainf., 1900, (—):46–9. Abstract Met. Zeits., 1902, **19**:281.

Comparative tables of evaporation at various stations. Summarizes results at Camden Square for 1885–1900 and Latham's results at Croydon.

Warington, Robert.

Lectures on some of the physical properties of the soil. Oxford. 1900.

Evaporation from a free water surface, from bare soil, and from soil covered with vegetation are discussed in some detail on. p. 107–26, quoting results of Ebermayer, King, Greaves, etc.

1901.

Abbe, Cleveland.

The rainfall and evaporation of Great Salt Lake. Mo. weather rev., 1901, **29**:68–91

Quotes A. J. Henry's table of the rainfall over the water-shed of Great Salt Lake, and estimates the rate of evaporation from salt water by applying Russell's (1888) observed rate from a fresh water surface.

Alberti, Vittoria.

Sul clima di Napoli, riassunto generale delle osservazioni meteorologiche fatte nella R. Specula de Capodimonte 1888–1900. Atti. r. ist. sci., Naples, **3**:(ser. 5), No. 4. Reprinted, Naples. 1901. 24 p.

Page 82 gives the monthly and annual evaporations at Naples from 1886–1900, with five-year means. The annual average is 730 millimeters, the maximum monthly rate, 100.1 millimeters (August), and the minimum, 34.4 millimeters (February).

Balch, E[dwin] S[wift].

Evaporation under ground. Mo. weather rev., 1901, **29**:545. Abstract in Exp. sta. rec., 1901, **13**:828.

Maintains that underground evaporation does not cause an appreciable lowering of temperature and that the cold within ice caves must be wholly due to the low temperatures of winter.

Bok, O.

Die Breusch. Zeits. Gewässerk., 1901, **4**:1–48.

A table on p. 45 gives the mean monthly depth of evaporation, together with results of observations of evaporation in meadow and forest, and the differences for the years 1891–5. Tables of rainfall, air temperature, relative humidity, and the water level of rivers are added.

Carpenter, L. C., and R. E. Trimble.

Meteorological observations for 1900. Colo. exp. sta. 13th Ann. rpt. Denver. 1901. 56 p.

Evaporation observations similar to those described in 1889. The monthly means during the years 1887–1900 vary from 1.24 inches in December to 5.63 inches in July. The mean annual evaporation was 41.16 inches and the average annual rainfall, 14.14 inches.

Chandler, Albert E.

Water storage on Cache Creek, California. Water sup. and irr. papers, 1901, No. 45:36–7.

Gives a table of the annual evaporation from Clear Lake, near San Francisco, for the years 1874–99, as observed by the State Engineering Department of California.

Davis, Arthur Powell.

Hydrography of the American Isthmus. Ann. rept. U. S. Geol. Survey, 1900–01, (—), Part iv, p. 507–630.

The evaporation from pans floating in Lake Nicaragua was observed at four stations. The monthly amounts for 1900 varied from 3.46 inches in August to 6.08 inches in May; the total amount for the year was about 52.4 inches.

Galli, D. Ignazio.

Esperienze coll' evaporimetro a livello costante. Atti accad. pont. nuovi Lincei, 1901, **54**:94.

In August, 1900, the author inaugurated comparative observations of evaporation of water in similar atmometers, one placed in the shade, but freely exposed to the wind; the other in the sun all day. No results are given. (See also Galli, 1899.)

Grunsky, C. E.

Water appropriations from King's River. In report of irrigation investigations in Cal., prepared by Elwood Mead. California exp. sta. bul., 1901, No. 100:259–325.

The experiments made by the California State Engineering Department under William Hammond Hall in 1881–5 at Kingsbury on King's River are described in the Appendix, p. 323–5. Two pans 36 by 36 by 15 inches with the water surface 5 inches below the rim were used, one floated in the river, the other placed on the bank. The average annual evaporation from the former was 3.851 feet, and from the latter 4.958 feet. The temperature of the water in the floated pan and of the river water were usually the same, while the water temperature in the pan on the ground varied considerably, being sometimes higher and sometimes lower than that of the river water.

Hann, Julius.

Lehrbuch der Meteorologie. 1st edition. Leipsic. 1901. 805 p.

A general survey of evaporation on p. 207–12. The phenomenon is defined as a function of temperature, humidity, wind velocity and air pressure. The formulas for calculating evaporation derived by Dalton, Weilenmann, Stelling, de Heen, Schierbeck, Trabert, Stefan, etc., are quoted.

Ingham, W.

Statistics dealing with evaporation, rainfall, and delivery of streams in Devonshire. Transactions of the Devonshire Association for the Advancement of Science, 1901, **33**:500. Abstract in Proc. inst. civ. engin., ——, **150**:506.

Measurements of evaporation from a free water surface in a tank at Kennich, Devonshire, for the years 1897–1900, show an annual average amount of 20.88 inches, or 50.81 per cent of the rainfall. Records of rainfall on the Torquay watershed for 23 years are also given.

König, Friedrich.

Die Verteilung des Wassers über, auf und in der Erde, und die daraus sich ergebende Entstehung des Grundwassers und seiner Quellen mit einer Kritik der bisherigen Quellentheorien. Geschildert für Tiefbautechniker, technische Forst-, Montan- und Landwirtschaftslehranstalten, sowie zum Selbstudium. Jena. 1901. 7 vol.

A general discussion of the conditions favoring evaporation appears in vol. 4, p. 53–69. By modifying the Dalton formula he calculates the yearly rates of evaporation for different mean annual temperatures. The rates corresponding to 0°, 5°, 10°, 15°, 20°, and 25° C. would be 340, 720, 1,030, 1,650, 2,270, 3,500 millimeters. These agree with the amounts actually observed at Cumaná, Venezuela, 3,520 mm.; at Madeira, 2,030 mm.; at Sidney, 1,200 mm.;

for Holland, 600–800 mm.; for the English coast, 900 mm.; for London, 650 mm.; and 800 mm. for East Scotland.

Manson, Marsden.

Features and water rights of Yuba River, Cal. In report of irrigation investigations in California prepared under the direction of Elwood Mead. Cal. exp. sta. bul., 1901, No. 100: 115–30.

A table of evaporation at Lake Fordyce (alt. 6,500 ft.) from Aug. 10–31, 1900, appears on p. 126. The daily average was 1/6 inch.

Müller-Erzbach, W.

Das Messen des Dampfdruckes durch Verdunstung. Sitzber. k. Akad. Wiss. (Vienna) math. naturw. Kl., 1901, **110** (pt. 2a):519–36.

The author concludes from his experiments that the vapor pressure of liquids may be determined with sufficient accuracy and more easily by evaporation than by manometric measurement.

Olmsted, Frank H.

Physical characteristics of Kern river, Cal. Water sup. and irr. papers, 1901, No. 46:25.

General statement of the losses due to evaporation and seepage.

Oppokow, E.

Das Verhalten des Grundwassers in der Stadt Neshin im Zusammenhange mit den meteorologischen Elementen. Zeits. Gewässerk., 1901, **4**:76–99.

Tables of rainfall, 1885–99, and evaporation, 1895–9, show an annual average for the former of 539 millimeters and for the latter of 379 millimeters.

Schuyler, James D.

Problems of water storage on torrential streams of southern California, as typified by Sweetwater and San Jacinto rivers. In report of irrigation investigations prepared under the direction of Elwood Mead. Calif. exp. sta. bul., 1901, No. 100:353–95.

The average annual rate of evaporation from Sweetwater Reservoir, from observations of several years, is 4.5 feet (p. 357).

Smythe, William E.

The irrigation problem of Honey Lake Basin, Cal. In report of irrigation investigations prepared unker the direction of Elwood Mead. Exp. sta. bul., 1901, No. 100:71–113.

The experiments of the California State Engineering Department, covering a period of five years, show the evaporation from Buena Vista, Kern, and Tulare lakes, which closely resemble Honey Lake, to be from 3.5 to 4.75 feet per year (p. 75).

Taihoku Meteorological Observatory.

Meteorological observations in Formosa, 1896–1901. Formosa. 1901.

The monthly evaporations at Taihoku, Taichu, Tainan, Taito, Koshun, Hokoto, and Keelung are given on p. 131–3. At Taihoku the monthly amount varies from 49.8 millimeters in February to 180.9 millimeters in July, and the annual average is 1266.2 millimeters. Tables of mean daily amounts and of daily maxima are also given.

Trimble, R. E.

See Carpenter, L. C., and R. E. Trimble.

U. S. Geological Survey.

Operations at river stations, 1900. Rpt. of the Division of Hydrography. Water sup. and irr. paper, 1901, No. 52:501.

Wallis, H. Sowerby, and Hugh Robert Mill.

Records of evaporation. Brit. rainf., 1901, (—):28–34.

Tables of evaporation for 1901 at nine stations, seven of which use standard tanks 6 feet square, with tables comparing evaporation throughout England, from 1888 to 1900. The average annual losses from the tank at Strathfield Turgiss, 18.03 inches for fourteen years (1870–83); from Miller's sand-protected evaporator at Lowestoft, 22.27 inches for twenty years (1878–97); from the tank at Camden Square, 15.19 inches for sixteen years (1885–1900) from Latham's floating atmometer at Croyden, 16.81 inches for fourteen years (1888–1901)

1902.

——————

Der Einfluss des Waldes auf die Verdunstung der Feuchtigkeit in seiner Umgegend. (Russian.) Lĕsoprom. vĕst., Moscow, 1902, (4), **49**:882-3.

Abbassia Observatory.

Report on meteorological observations, 1900. Public Works Department of Egypt, Survey Department. Cairo. 1902.

Tables of hourly evaporation (Wild evaporometer) and daily totals for the year 1900, show an annual evaporation of 1778.7 millimeters.

Davis, Walter G.

Climate of the Argentine Republic compiled from observations made to the end of the year 1900. Buenos Aires. 1902.

Observations described in Davis, 1900, are continued on p. 83–90, with tables including results from 1886–1900.

Desenzano, Osservatorio Meteorologico.

Osservazioni meteorologiche. Comment. Ateneo, Brescia, 1902, (—): 421–26.

The total evaporation at Desenzano, at the south end of Lake Garda, for the year from September, 1901, to August, 1902, inclusive, was 688.9 millimeters, the monthly amounts varying from 14.0 millimeters in February to 131.9 millimeters in July.

Hungary.

Königliche Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus, Jahrbuch, 1902, **32**:97.

The daily evaporation at O-Gyalla during 1902 was 1.4 millimeters.

Jaubert, Joseph.

Annales de l'observatoire municipal (Observatoire de Montsouris), 1902, **3**:137–41, 222–6, 301–3.

The Piche evaporometer was employed at Montsouris and at the Tour St. Jacques in Paris. The water was usually frozen in the winter months. At Montsouris the monthly amount varied from 40.7 millimeters in October to 148.0 millimeters in July, and at the Tour St. Jacques from 69.3 millimeters in October to 177.8 millimeters in July.

Lippincott, J. B.

Storage of water on King's river, Cal. Water sup. and irr. papers, 1902, No. 58:22–4, 81–2, 99.

Tabulation of the observations of evaporation at Kingsbury, Cal., reported by Hall (1886) and quoted by Grunsky (1901). Summary of measurements made in King's river canals in August and September, 1901, to determine the loss by seepage and evaporation.

Memmo, Osservatorio Meteorologico.

Osservazioni meteorologiche. Comment. Ateneo, Brescia, 1902, (—): 428–32.

The maximum observed monthly evaporation for the year, September, 1901, to August, 1902, was 57.7 millimeters in July, 1902. Records were not obtained during the winter months owing to the freezing of the water in the instruments. The type of instrument is not indicated.

Okada, T.

Ueber die Evaporationskraft des Föhn. Met. Zeits., 1902, **19**:339–42.

In Japan the foehn is usually a northwest wind of considerable violence and greatly accelerates the rate of evaporation from water in a small copper dish freely exposed in an open place. Observations are tabulated.

Ridgway, C. B.

Experiments in evaporation. Wyoming exp. sta. bul., No. 52. Laramie. 1902.

For these experiments a tank was used having a perforated bottom and containing soil supplied with water from a larger reservoir directly below, the whole apparatus being sunk in the ground. Water was supplied to the reservoir through a tube leading from the surface of the ground. A float in the tube actuated a pointer moving over a graduated scale which reached above the ground, and showed the variations of the water level. The rate of evaporation from soil with the water level maintained 6 inches below the soil surface, was 95 per cent of that from a free water surface in the evaporation tank. With the water level 12, 18, and 22 inches below the soil surface, the evaporation was 70, 45, and 35 per cent respectively. Loosening the soil once a week to the depth of 2 inches diminished the evaporation 10 per cent; to the depth of 4 inches, 23 per cent; and to 6 inches, 45 per cent.

Salo. Osservatorio Meteorologico.

Osservazioni meteorologiche. Comment. Ateneo, Brescia, 1902, (—): 434–7.

The average daily evaporation at Salò, on Lake Garda, for the year September, 1901, to August, 1902, inclusive was 2 2 millimeters.

Schwalbe, G.

Ueber die Darstellung des jährliches Ganges der Verdunstung. Met. Zeits., 1902, **19**:49–59.

The following formula for calculating evaporation is presented: $v'=A'(t-t')$, where $v'=$ calculated evaporation, $A'=$a constant embracing the wind factor and varying from 0.46 to 1.2 at different places, $(t-t')=$ the difference between the readings of the wet- and dry-bulb thermometers. This formula was tested at 19 stations in Russia. Curves comparing the observed and calculated values, v and v', at several places, lead to the conclusions: (1) $(t-t')$ is a relative measure of the evaporation. (2) The yearly march of $(t-t')$ and v both depend on the sun's declination and in the same way.

There is a concise discussion of the formulas developed by Dalton, Stefan, Weilenmann, Stelling, de Heen, Ule, Krebs, Schierbeck, and Trabert, and a uniform notation is employed in writing them.

Taylor. L. H.

Water storage in the Truckee Basin, California-Nevada. Water sup. and irr. paper, 1902, No. 68: 34–6.

Monthly evaporation observed from a tank floated on the surface of Lake Tahoe, Cal., from May, 1900, to December, 1901, together with calculations of the inflow and outflow, served to determine the reduction of the lake level, which corresponded very closely with the reduction as observed by means of a fixed gage. The results of evaporation at Reno, Nev., during 1894, from a somewhat smaller tank sunk in the ground and surrounded with moist soil are tabulated.

U. S. Department of Agriculture, Office of Experiment Stations.

Report on irrigation investigations for 1901. Off. Exp. Sta., 1902, Bul. 119.

On p. 92, 294, 334–6, and 353 are records of evaporation secured by agents of the Office of Experiment Stations at various places in Arizona, Colorado, Montana, Nevada, New Mexico, New Jersey, Utah, Washington, and Wyoming.

Wallis, H. Sowerby, and Hugh Robert Mill.

Records of evaporation. Brit. Rainf., 1902, (—): 49–53.

Tables similar to those of the preceding years. For succeeding records see Mill, Hugh Robert.

1903.

Barus, Carl.

Absence of electrification in cases of sudden condensation and of sudden evaporation. Phys. rev., 1903, **16**:384.

Ordinary evaporation and condensation have long been known to be unaccompanied by electrification, but when a mass of water is suddenly shattered as in jets, there is a marked production of electricity. The question arose, therefore, as to whether the absence of an electric effect in ordinary evaporation and condensation cases was not due to the fact that the charges vanish too quickly to be noticeable. Further experiments, however, with sudden condensation and evaporation showed an absence of electrification.

Batavia, Koninklijk magnetisch en meteorologisch Observatorium.

Results of meteorological observations made at the experiment station "Oost-Java" at Pasuruan, during the year 1902. Natkdg. Tijdsch. Ned. Ind., 1903, **62**: 267–72.

Includes observations on evaporation.

Bok, Oscar.

Verdunstungsmessungen nebst Untersuchungen über die Verdunstungshöhen an den forstlich-meteorologischen Stationen in Elsass-Lothringen. Beitr. Geophysik, Leipsic, 1903, **6**:1–16.

Desenzano, Osservatorio Meteorologico.

Meteorologia. Comment. Ateneo, Brescia, 1903, (—):139–43.

The monthly evaporation at Desenzano for the year from September, 1902, to August, 1903, inclusive, varied from 14.70 millimeters in January to 113.80 millimeters in August.

Hall, A. D.

The soil. An introduction to the scientific study of the growth of crops. New York. 1903.

Discusses (p. 120–2) the amount of heat required for evaporation, with tables and curves of soil temperatures showing the cooling effect of the evaporation of soil moisture. The advantage of cultivation of the surface soil in decreasing evaporation, owing to the breaking of the capillary channels, is pointed out (p. 92–101) and King's experiments with glass cylinders full of fine sand are described.

Hann, J.

J. R. Sutton—Experimente über Verdunstung. Met. Zeits., 1903, **20**:517–8.

Discusses the experiments of Sutton (1903) and Latham (1897–1904), on the influence o

different methods of measuring evaporation, and considers: (1) the size of the evaporator, (2) the capillary attraction of the walls, (3) the enamelling of the outside surface, (4) the material of the instrument, (5) the influence of relative humidity and wind velocity, (6) the probability that the influence of the surface temperature of the water has been over estimated.

Jaubert, Joseph.
Notice sur l'évaporomètre de Montsouris. Ann. obs. Montsouris, 1903, **4**:30–2.

Describes an instrument for measuring evaporation from soil. It consists of a sheet iron box, 30 by 30 by 30 centimeters, filled with soil in which grass is allowed to grow. The variations in weight of the soil are registered automatically by a steel-yard balance on which the box rests. The whole is placed in the ground, so that its upper surface is on a level with that of the surrounding soil. The excess water in the box may be drawn off by means of a pipe soldered to the bottom of the box. The author believes the disadvantage of this method of determining soil moisture to lie in the fact that the soil in the box dries out more rapidly than natural soil, the latter being able to draw new supplies of moisture from lower layers.

Jelinek, Carl.
Jelinek's Psychrometer-Tafeln erweitert und vermehrt von J. Hann, neu herausgegeben und mit Hygrometer-Tafeln versehen von J. M. Pernter. Fünfte erweiterte Auflage. Leipsic. 1903.

Lindgren, Waldemar.
The water resources of Molokai, T. H. Water sup. and irr. paper, 1903, No. 79:48.

The probable amount of evaporation was calculated from the rainfall and runoff for separate areas.

Memmo, Osservatorio Meteorologico.
Meteorologia. Comment. Ateneo, Brescia, 1903, (—):144–7.

The average daily amount [of evaporation] for the year was 2.4 millimeters.

Mill, Hugh Robert.
Records of evaporation. Brit. rainf., 1903, (—):38–41.

The evaporation for the year (11 stations) was 17.7 inches. Latham's table of evaporation at Croydon appears as usual. The water in his 5-inch exposed vessel evaporated twice as much during the winter and spring, and in the summer only about 1.5 times as much as that in the 12-inch floating evaporator. A second table by Latham shows the amount of percolation at several stations.

Müller-Erzbach, W.
Der Dampfdruck des Wasserdampfes nach der Verdampfungsgeschwindigkeit. Sitzber. k. Akad. Wiss. (Vienna) math. naturw. Kl., 1903, **112**(pt. 2a):615–20.

The vapor pressures derived from the rate of evaporation from tubes are found to agree closely with those given by Regnault.

Naples. R. Osservatorio di Capodimonte.
Osservazioni meteoriche. Rend. soc. sci., 1903, **9**(3d ser.):16, 65, 98, 146, 168, 184, 219, 261–4, 307.

The monthly evaporation for 1903 varied from 38.1 millimeters in January to 112.3 millimeters in September, with the rainfall varying from zero in August to 196.4 millimeters in December.

Okada, T.
Vergleichende Messungen der Verdunstung des Meerwassers und des Süsswassers. Met. Zeits., 1903, **20**:380–4.

Under similar conditions, the ratio between the mean daily evaporation from salt and fresh water at Azino, Japan, was 0.950, and nearly constant for all seasons. Tables show the daily maxima and the monthly means from January, 1895, to December, 1901. The most important elements influencing evaporation are thought to be air temperature and insolation. Devises the formula

$$D = ax + by,$$

Where D = fresh water minus sea water,
x = temperature of the air,
y = daily duration of sunshine,
$a, b,$ = constants, = 0.079 and 0.076, respectively, at Azino, in western Japan.

Oppokow, E.
Zur Frage der vieljährigen Abflusschwankungen in den Bassins grosser Flüsse, im Zusammenhang mit dem Gang der meteorologischen Elemente. Vergleichende Untersuchung des Abflusses im Gebiete des Dnjepr oberhalb der Stadt Kijew und der oberen Elbe in Böhmen. Zeits. Gewässerk., 1903, **5**:340–65.

Includes curves of rainfall, evaporation, and runoff from 1874–94, with a table of the yearly amounts from 1875–94 on the Elbe in Bohemia.

Perman, D. E. P.
The evaporation of water in a current of air. Communicated by Prof. E. H. Griffiths, F. R. S., to the Royal Society, February 19, 1903. Nature, 1903, (—):477.

Rafter, George W.
The relation of rainfall to runoff. Water sup. and irr. paper, 1903, No. 80:30–43.

Papers by Vermeule (1893 and 1900) are abstracted. Computes the evaporation from the Muskingum basin, N. Y. (O?). Definition and tables of so-called "negative evaporation" are added.

Russell, H. C.
Results of rain, river, and evaporation observations made in New South Wales during 1900. Sydney. 1903.

Salo, Osservatorio Meteorologico.
Meteorologia. Comment. Ateneo, Brescia, 1903, (—):148–55.

The average daily evaporation from September, 1902, to August, 1903, inclusive, was 2.4 millimeters.

Sutton, J. R.
Results of some experiments on the rate of evaporation. Trans. So. African phil. soc., 1903, **14**, pt. 1. Review in Met. Zeit., 1903, **20**: 517–8. Reprinted, 23 p., 8vo.

Compares the evaporation from various containers and from a Piche tube. Finds that the latter instrument is especially susceptible to the influence of the wind. The experiments of 1900 lead to the conclusions: (1) The humidity of the air exerts the most powerful influence on the rate of evaporation. (2) A wind factor is needed. (3) The great perturbing influence attributed to the temperature of the water has not been wholly confirmed.
Experiments with colored glass over the evaporating surface show that for each 1° excess of temperature due to such influence the depth of annual evaporation will increase by 1.5 inches.

Ule, Willi.
Niederschlag und Abfluss in Mitteleuropa. Forschungen zur Deutschen Landes- und Volkskunde, Stuttgart, 1903, **14**:435–516.

In the upper Saal valley the average rainfall for the 20 years, 1882–1901, was 615 millimeters, and the average run-off 170 millimeters. The run-off is 27.5 per cent, the evaporation is estimated at 51.5 per cent, and vegetation uses 21 per cent. This would make the average annual evaporation for this region about 316.7 millimeters.

Vlasov, V. A.
Observations météorologiques de la station du champ d'expérience de Poltava, 1886–1900. Vol. II: Dépôts atmosphèriques, évaporation, etc. (Russian and french.) Poltava. 1903. 633 p.

1904.

Batavia, Koninklijk magnetisch en meteorologisch Observatorium.
Results of meteorological observations made at the Experiment station "Oost-Java" at Pasuruan, during the year 1902. Natkdg. Tijdsch. Ned. Ind., 1904, **63**:220–5.

Includes observations on evaporation.

Black, William Galt.
Observations of rain, dust, and evaporation, Edinburgh, 1903. Symons's met. mag., 1904, **39**:29.

Bologna, Osservatorio della R. Università.
Osservazioni meteorologiche fatte durante l'anno, 1903. Mem. accad. sci., Bologna, 1904, **1**, (6th ser.):325–53.

The total evaporation for 1903 was 1234.5 millimeters, the rainfall was 547.9 millimeters.

Burgerstein.
Die Transpiration der Pflanzen. Jena. 1904.

An exhaustive and critical bibliography of works dealing with transpiration from plants.

Curtis, Richard R.
Water-vapor. Quart. jour. roy. met. soc., 1904, **30**:193–209.

A general survey of the physics of evaporation with a statement of the relative amounts of rainfall and evaporation in the British Isles.

Desenzano, Osservatorio Meteorologico.
Osservazioni fatte nel 1903. Comment. Ateneo, Brescia, 1904, (—): 185–9.

The total evaporation for the year September, 1903, to August, 1904, inclusive, was 852.7 millimeters.

Gibbs, L.
Evaporation from the land. Quart. jour. roy. met. soc., 1904, **30**: 39–40.

Discusses literally and graphically the effect of the duration and character of the rainfall on the evaporation.

Hungary.
Königliche Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus. Jahrbuch, 1904, **34**:218, 219.

At Nagytagyos the total evaporation for 1904 was 352.4 millimeters, and at Temesvár 494.4 millimeters.

Jaubert, Joseph.
Observatoire Municipal [de Paris], (Observatoire de Montsouris) Annales, 1904, **4**:19, 94–6, 220–4, 383–7.

At Montsouris the monthly totals varied between 92.6 millimeters in October to 173.5 millimeters in July; at the Tour St. Jacques they varied between 41.4 millimeters in October to 118.1 millimeters in July. No records are given for the winter months.

Kimball, Herbert Harvey.
Evaporation observations in the United States. Mo. weather rev., 1904, **32**:556–9. Reprinted U. S. Dept. Agric., Weather Bur., No. 327. Washington. 1905.

Quotes Rafter's (1903) computations of evaporation from the run-off and rainfall over a watershed for different localities during long periods. Two other methods of determining evaporation are considered as of more practical importance—by direct measurements from properly exposed water surfaces, and by computations based upon the temperature of the water surface and the values of certain meteorological elements. The formulas of T. Russell, Fitzgerald, Carpenter and Stelling are compared and discussed. An account of experiments made by the U. S. Geological Survey in 1888 in the arid regions is followed by a table of measured annual evaporations at various stations, for the purpose of checking Russell's computed values. Reproduces T. Russell's chart of evaporation over the United States.

Krebs, Wilhelm.
Ueber Verdunstungsmessungen mit dem Doppelthermometer für klimatologische und hydrographische Zwecke. Verhdl. Deut. phys. Gesellsch., 1904, **6**:278–9.

See Krebs, 1905.

Luedecke, Carl.
Ueber die Grösse der Bodenverdunstung bei verschiedenen Tiefe des Grundwasserspiegels. Kulturtechniker, Breslau, 1904, **7**:195–8.

Memmo, Osservatorio Meteorologico.
Osservazioni fatte nel 1903. Comment. Ateneo, Brescia, 1904, (—): 190–7.

The total evaporation for the year from September, 1903, to August, 1904, inclusive, was 390.1 centimeters.

Mill, Hugh Robert.
Records of evaporation. Brit. rainf., 1904, **44**:46–51.

Gives observations from the same stations as in 1903. The results obtained at the eleven stations average 17.32 inches, with a rainfall of 26.49 inches.

Mitscherlich, Alfred.
Ein Verdunstungsmesser. Landw. Vers. Stat., 1904, **60**:63–72, and 1904, **61**:320.

The author considers measurements of evaporation from open vessels of little value for agricultural purposes, since the instrument usually can not be placed in the open on account of rain, and because the edge of the vessel always protects the surface of the water from the full action of the wind. He devises an instrument essentially that described by Babinet, 1848, and Marié-Davy, 1869. The evaporation per square centimeter indicated by this instrument was to that from a free water surface as 1.94 to 1 for a large cylinder, and 1.29 to 1 for a smaller one. This apparatus exposed in the writer's experimental field at Kutschlau near Schwiebus, Brandenburg, from April 5 to July 20, 1903, indicated an evaporation of 190.14 millimeters, while the rainfall was 205.50 millimeters. At Kiel the evapo-

ration was only about one-half to one-third that at Kutschlau and the rainfall was considerably greater. Recommends this evaporometer as a substitute for the registering hair hygrometer.

Naples. R. Osservatorio di Capodimonte.
Osservazioni meteoriche. Rend. accad. sci., fis. math. Sez., Naples, 1904, 10 (3d ser.): 38, 78, 180–1, 267–9, 323–6, 400.

The monthly amounts of evaporation in 1904 varied from 46.9 millimeters in January to 134.6 millimeters in July. The rainfall varied from 17.6 millimeters in July to 157.1 millimeters in October.

Okada, T.
Evaporation in Japan. Bul. cent. met. obs., Japan, 1904, No. 1:31.

Evaporation is observed at fifty stations in Japan. The evaporometer is a cylindrical, zinc-lined copper vessel, 20 centimeters in diameter and 10 centimeters deep. A table of comparative observations in sun and shade for 1891–1893 shows that the difference is greatest in summer and least in winter. Tables of the mean daily and the monthly evaporation for the fifty stations show minima in January and June and a maximum in August. Geographically the annual evaporation in Japan decreases from 1,910 millimeters at Koshun in the southwest, to 734 millimeters at Kushiro in the northeast. The annual rainfall usually exceeds the evaporation. The monthly evaporation at twelve stations is shown graphically and a chart presents the distribution of evaporation over Japan.

Oppokow, E.
Zur Frage der vieljährigen Abflussschwankungen in den Bassins grosser Flüsse, im Zusammenhang mit dem Gang der meteorologischen Elemente. Vergleichende Untersuchung der mittleren Abflusswerthe im Flussbecken des oberen Dnjepr und der oberen Elbe in Zusammenhang mit der Frage über Charakter und Grenzen des Einflussen der Lokalitäten eines Flussbeckens auf den Abfluss. Zeits. Gewässerk., 1904, 6: 1–23.

The percentage of the rainfall evaporating from a bare moor soil was found to be 29.3, and the run-off 59 per cent. For a mixture of moor soil and sand lying over moor soil the figures were 25.5 and 63 per cent. For moor soil covered with coarse sand, 11.6 and 87 per cent.

Oppokow, E.
Zur Frage der vieljährigen Abflussschwankungen in den Bassins grosser Flüsse, im Zusammenhang mit dem Gang der meteorologischen Elementen. Ueber Aufspeicherung und Consum der Feuchtigkeit im Bassin des oberen Dnjepr. Zeits. Gewässerk., 1904, 6: 156–75.

The evaporation and seepage are calculated from the rainfall and run-off. Tables and curves are presented for the basin of the Dnieper, and tables from R. Scheck and Ule for the basin of the Saal, 1872–1901. (See Ule, 1903.)

Oppokow, E.
Einige Daten über die Schwankungen des Abflusses und der absoluten Verdunstung in den grossen Flussbassins im Zusammenhang mit den Klimaschwankungen und dem Einfluss der Boden- und Pflanzen-Bedeckung. (Russian.) Pédologie, St. Petersburg, 1904, 6:182–9.

Russell, H. C.
Results of rain, river, and evaporation observations made in New South Wales during 1901–2. Sydney. 1904.

Salo, Osservatorio Meteorologico.
Osservazioni fatte nel 1903. Comment. Ateneo, Brescia, 1904, (—): 198–204.

The average daily amount for the year September, 1903, to August, 1904, inclusive, was 2.7 millimeters, ranging between 0.6 millimeters in December, and 6.4 millimeters in July.

Sutton, J. R.
On certain relationships between the diurnal curves of barometric pressure and vapor tension at Kenilworth (Kimberley), South Africa. Quart. jour. roy. met. soc., 1904, 30:41–55.

A modern discussion of the physics of evaporation with consideration of the theories proposed by Dalton, Lamont, and Deluc. Concludes that changes in the barometer may be due to changes in the vapor pressure rather than to those of temperature.

Sutton, J. R.
Results of some further observations upon the rate of evaporation. Rpt. So. African assoc. adv. sci., Johannesburg. 1904.

Experiments from 1900–04 with a Piche atmometer and the evaporometer described in

Sutton, 1903, shows the highest rate from the Piche in the daytime, but not at night. It is concluded that this may be due to the stronger winds of the day, and possibly to the greater range of the temperature of the water in the Piche. Quotes similar results by Shaw. In summer the ratios between the instruments are more nearly equal than in winter. A mathematical discussion seeks to determine the relation of the different factors which influence the evaporation rate.

1905.

Abbe, Cleveland.

The Piche evaporometer. Mo. weather rev., 1905, **33**:253–5.

Summarizes Russel's (1888) results. Describes the Piche atmometer, and gives a table showing the effect of wind upon the rate of evaporation. "The true method of treating evaporometers of all kinds within instrument shelters is to consider them as integrating hygrometers. For such exposures the total evaporation during an hour or a day is a simple result of the temperature, the wind, and the dryness. Knowing the two former and the measured evaporation, we may compute the average dryness. This average dryness is a much more important datum to the meteorologist than is the measured evaporation to the climatologist. Of course, hydraulic and irrigating engineers need to know the loss of water by evaporation, but in nature this is so mixed up with seepage, leakage, and consumption by animals and plants, that our meteorological data are of comparatively of little importance. For the agricultural engineer the lysimeter and Symons' evaporometer, 6 feet square, are essential apparatus, but for the meteorologist an integrating hygrometer, such as the Piche evaporometer really is, is the important instrument."

Bacon, Arthur A.

The equilibrium pressure of a vapor at a curved surface. Phys. rev., 1905, **20**:1–9.

Discussion of the laws regulating the equilibrium between evaporation and condensation at the surface of a liquid in capillary tubes, with a résumé of the history of the subject.

Bentley, Richard.

The growth of instrumental meteorology. Quart. jour. roy. met. soc., 1905, **31**:173–92.

Two paragraphs on evaporometers occur on p. 185 and 196. Richard's (1898) self-recording evaporation gage and Symons's evaporation tank are described.

Boname, P.

Meteorologie. Rap. ann. sta. agron. Mauritius, 1905, (—):1–10. Abstract in Exp. sta. rec., 1906, **18**:311.

The annual evaporation in Mauritius for 1905 was 376.2 millimeters, with a rainfall of 2,410.2 millimeters. This is said to have been an unusually wet year.

Brückner, Eduard.

Die Bilanz des Kreislaufs des Wassers auf der Erde. Geogr. Zeits., 1905, **11**:436–45. Abstract in Arch. sci. phys. et nat., 1905, **20**: 427–30.

General survey of the evaporation measurements made in different parts of the earth and the part played by evaporation in the cycle of the waters of the earth.

Day, W. H.

Experiments on evaporation and transpiration. Ann. rpt. Ontario agr. coll. and expt. farm, 1905, **31**:40–2. Abstract, Exp. sta. rec., **17**: 841.

Studies on the amount of water required by wheat, barley, oats, and peas show that barley requires the least water for growth and peas the most. An attempt to use the Piche evaporometer for purposes of comparison showed that several instruments "would not record the same amount under the same conditions nor even amounts bearing constant ratios to one another."

Desenzano, Osservatorio Meteorologico.

Osservazioni fatte nel 1904. Comment. Ateneo, Brescia, 1905, (—): 157–61.

The monthly evaporation for the year from September, 1904, to August, 1905, inclusive, varied from zero in December, and 1.2 millimeters in January to 104.2 millimeters in August.

Fortier, Samuel.

Loss of water by evaporation. Engin. rec., 1905, **51**: 430.

Very comprehensive experiments in evaporation, undertaken by the Office of Exp. Stas. and the State of California, show that the amount of evaporation is largely dependant on the temperature of the water. The rate of evaporation from cultivated soil seems to depend on the amount of soil moisture, on the temperature and physical character of the soil, the condition of the atmosphere, the wind, etc. Experiments in irrigation indicate that surface flooding is most wasteful and that furrows 12 inches deep conserve much more moisture than do shallow furrows of 3 inches. The average evaporation under each method, during September and October, was 6428, 5581, and 4811 cubic feet per acre, respectively.

Gessert, F.

Die Grundwasserverdunstung in Steppen, speciell Südwest-afrika. Zeits. Kolonialpol., Berlin, 1905, **7**:301. Translated by L. Laloy in Bul. soc. géog., 1905, **12**:53–5.

The cause of the high evaporation rate from the steppe soils of Southwest Africa are given as: (1) circulation of air through the porous soils due to differences in temperature. (2) destruction of forests which formerly covered the soil, by erosion and periodic burning. (3) strong capillary action.

Evaporation is shown to produce an increase in the salt content of the upper layers of the soil. The amount of evaporation is estimated as probably more than the runoff of streams. The remedies for excessive evaporation are believed to lie in changing evaporation from the depths to the surface, either by pumps in some particular cases, or in a more general manner by reestablishing a plant cover such as dates and cactus.

Hall, A. D.

The Book of the Rothamsted Experiments. London. 1905. xl, 294 p.

Results of percolation experiments, averaged for each month for 34 years (1871–1904), appear on p. 22–3. The average annual rainfall was 28.98 inches, of which 15.8 inches was evaporated or retained by the soil in a 20-inch gage, 14.25 inches in a 40-inch gage, and 15.19 inches in a 60-inch gage.

Hungary.

Königliche Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus. Jahrbuch, 1905, **35**:224, 225.

The monthly evaporation in 1905 at Temesvár varied from 8.2 millimeters in January to 81.3 millimeters in July, with a total for the year of 430.4 millimeters. At Nagytagyos the monthly amount varied from 6.7 millimeters in November to 72.9 millimeters in August, with a total of 331.3 millimeters.

Krebs, Wilhelm.

Ueber Verdunstungsmessungen mit dem Doppelthermometer für klimatologische und hydrographische Zwecke. Met. Zeits., 1905, **22**:211–21.

Measurements of evaporation from tanks placed in the waters of Mansfelder Lake in June, 1894, in Platten Lake, in October, 1894, and in White Lake in the High Vosges in July, 1903, are compared with the readings of the wet- and dry-bulb thermometers.

Memmo, Osservatorio Meteorologico.

Osservazioni fatte nel 1904. Comment. Ateneo, Brescia, 1905, (—): 162–5.

The total evaporation for the year, from September, 1904, to August, 1905, inclusive, was 344.1 millimeters. The water in the instrument was frozen during the three winter months.

Mill, Hugh Robert.

Relation of evaporation from a water surface to other meteorological phenomena in 1905, at Camden Square. Brit. rainf., 1905, **43**:35–9.

Curves of the evaporation, temperature, etc., at Camden Square, are presented. When the curve of the rate of evaporation was below the average for the year it followed that of the mean temperature; when it was above the average it followed those of the duration of sunshine and the black-bulb temperature. The wind appeared to have little effect at any time.

Mill, Hugh Robert.

Records of evaporation. Brit. rainf., 1905, **45**:40–4.

Evaporation for the year, averaged from records at eleven stations in the British Isles, was 17.72 inches, with a rainfall of 25.35 inches.

Mitscherlich, Alfred.

Bodenkunde für Land- und Forstwirte. Berlin. 1905.

In section 35, p. 204–13, the author discusses evaporation from soil. He cites Eser, Ebermayer, Meister, Vogel, and Wollny on the influence of the size of the soil particles, the kind of soil, the vegetation, the inclination of the surface, the depth of the ground water and the capillary power of the soil, tillage of the soil, and mulches. Additional tables on p. 300–3 compare evaporation from free water surfaces with that from various kinds of soil and vegetation.

Salo, Osservatorio Meteorologico.

Osservazioni fatte nel 1904. Comment. Ateneo, Brescia, 1905, (—): 168–71.

The average daily evaporation varied from apparently zero in February and March and 0.7 millimeter in December to 4.3 millimeters in July.

Shchusev, S. [V].

La méthod de détermination de l'humidité des sols. (Russian.) Pédologie, St. Petersburg, 1905, **7**:63–6.

Shipchinskii, V. V.
Un cas d'évaporation. (Russian.) Met. Vest., 1905, **15**:87–95.

Slovinskii, — —.
[Meteorological observations for the year 1905 at the Ploti agricultural experiment station.]
Godīchnuïï Otchet Ploty. Selsk. Khoz. Opuitn. Stantziī., 1905, **11**:1–24, 121–4. Abstract, Exp. sta. rec., 1906, **18**:311.

Observations on evaporation, in connection with other meteorological data.

Strachan, Richard.
On percolation gages. Horological journal, London, 1905, **47**:115–7.

Several well-known percolation gages and those used at Rothamsted are described; also a self-recording apparatus designed and constructed by Messrs. Richard Frères.

Strachan, Richard.
On evaporation gages. Horological journal, London, 1905, **47**:129–34, 157–61; 1905, **48**:19–24, 40–5, 50–4.

General discussion of various classes of evaporometers, with detailed historical and bibliographical survey of examples of all kinds, and some treatment of evaporation from a mathematical point of view.

Strachan, Richard.
Measurement of evaporation. Quart. jour. roy. met. soc, 1905, **31**: 277–84.

Evaporation (15.04 inches) as calculated from the meteorological data for 1898 obtained at the Royal Observatory, Greenwich, is compared with the observed evaporation at Camden Square (15.16 inches) and at Rothamsted (15.67 inches). Discusses Pole's formula (see Latham, 1900), and two proposed by R. J. Mann (1871), all of which are regarded as inapplicable. Abbe and Fitzgerald are quoted, and T. Russell's experiments on the influence of the wind on a Piche tube. "The necessity, however, is made apparent of improving the accuracy of evaporometers, and of the importance of achieving a standard instrument of this class." The formula used at the Royal Observatory for calculating evaporation is as follows: The depth of water evaporated in a month $= 13.59\ (V - v)\ ab$, where $V =$ vapor pressure at the temperature of the air, $v =$ vapor pressure at the dew-point, $a =$ mean daily temperature of the evaporating water, and $b =$ coefficient of expansion of water.

Transeau, Edgar N.
Forest centers of eastern America. Amer. nat., 1905, **39**:875–89. See also Ann. rpt. Mich. acad. sci., 1905.

Draws lines of equal ratios between rainfall and evaporation in eastern North America, Russell's (1888) chart being used as the basis for the evaporation data. Finds that these lines indicate "climatic centers" corresponding in general with the centers of plant distribution which latter are resultants of temperature, relative humidity, wind velocity, and rainfall.

Wada, Y.
Japanese meteorological service in Korea and Manchuria. (Translated by Dr. S. Tetsu Tamura.) Mo. weather rev., 1905, **33**:397–9.

At Chemulpo Observatory the total evaporation from an 8-inch evaporometer for the year June, 1904, to June, 1905, was 1254.8 millimeters. The monthly rates varied between 175.6 millimeters in June, 1905, and 59.0 millimeters in January, 1905. The total rainfall for the year was 707.6 millimeters.

1906.

Alfaro, Anastasio.
Costa Rican climatological data. Mo. weather rev., 1906, **34**:60, 305.

The total evaporation for January, 1906, was 62.5 inches, and for March, 67.9 inches.

Boulatovitch, M.
Meteorological observations for the year 1906 at the Ploti Agricultural Station. Godīchnuïï Otchet Ploty. Selsk. Khoz. Opuitn. Stantziī, 1906, **12**:1–34, 229–34. Abstract, Exp. sta. rec., 1907, **19**: 616.

Evaporation for the year is given as 27.56 inches, the mean of 12 years being 32.78 inches.

Day, W. H.
Evaporation. Ann. rpt. Ontario agr. coll. and exp. farm, 1906, **32**: 31, 32. Abstract, Exp. sta. rec., 1907, **19**:11.

Observations of evaporation from a reservoir during the six months, June to November, showed a loss of 37.69 inches, or about 10 inches more than the mean annual rainfall for this place.

Fritsche, Richard.

Niederschlag, Abfluss und Verdunstung auf den Landflächen der Erde. Inaug. Diss. Halle-Wittenberg. Halle. 55 p. 8vo. Zeits. Gewässerk., 1906, **7**:321–70. Reviews, Naturw. Rundschau, 1907, **22**:111; Petermann's Mitteil., 1907, **53**:16 (Literaturbericht); Exp. sta. rec., 1908, **20**:114.

General estimates of annual rainfall, run-off, and evaporation on the land surfaces of the globe, revised from Murray (1887), and Brückner (Met. Zeits., 1887, **4**:[63]), and gives a table of evaporation according to latitude. (See also Brückner, 1908.)

Ginestous, C.

Meteorology of Tunis, winter of 1905–6. Bul. dir. agr. et com., Tunis, 1906, **10**:114–28. Abstract, Exp. sta. rec., 1906, **18**:10.

Sumarizes observations on pressure, temperature, humidity, rainfall, evaporation, etc., at a large number of stations in different parts of Tunis.

Hann, Julius.

Täglicher und jährlicher Gang der Verdunstung in Südindien. Met. Zeits., 1906, **23**:428–9.

Describes some experiments carried on at Trivandrum from 1857 to 1863 by John Allen Brown. Two evaporators, having exposed surfaces of 100 square inches, were filled with sea water, and placed, one in the shade, though exposed to wind, the other in the sun. The evaporation maxima fell in March and September, the minima in June, July, and November. The table of mean daily evaporation gives the annual amounts of 1032.36 millimeters in the shade, and 2523.94 millimeters in the sun.

Henry, Alfred J.

Salton Sea and the rainfall of the Southwest. Mo. weather rev., 1906, **34**:557–9.

Shows that the Salton Sea could not affect the rainfall of the Southwest.

Hilgard, E. W.

Soils, their formation, properties, composition, and relations to climate and plant growth in the humid and arid regions. New York. 1906. xvii, 593 p.

On p. 192–4, 253–66, and 455 discusses the relation of evaporation to agriculture. On p. 253 the section "Evaporation" includes a general discussion of evaporation from soil and water surfaces. Fortier's (1905) experiments showing the influence of temperature on evaporation from water, are described, and a table of evaporation in different climates is presented.

Keeling, B. F. E.

Note on evaporometers. Mo. weather rev., 1906, **34**:157.

An account of the results of comparisons of the indications of various evaporometers as made at Helwan Observatory, Helwan, Egypt. The results are given in tabular form, and show that the mean ratio of the Piche to the Wild evaporometer readings is 1.44; that of the Wade to the Wild is 1.37, and that of the Wade to the Piche is 0.96. The ratio Piche to Wild, 1.44, is about 10 per cent greater than that found by T. Russell, but this difference is probably to be explained by the difference in the dimensions of the instruments. Describes the Wade evaporometer designed by E. B. H. Wade, of the Survey Department of Egypt.

Keller, H.

Niederschlag, Abfluss und Verdunstung in Mitteleuropa. Zentralblatt der Bauverwaltung, Berlin, 1906, **26**:279. Also Jahrb. Gewässerk., Besond. Mitt., Berlin, I, 1906, 4, p. 43.

The main results may be tabulated as follows:

Region.	Rainfall.	Run-off.	Evaporation.
	Mm.	*Mm.*	*Mm.*
North-central Europe	610	150	460
Danube-Rhone region	962	502	460
Central Europe in general	714	268	446

Ladd, E. F.

Summaries of temperatures, rainfall, sunshine, and evaporation. North Dakota exp. sta. rpt. for 1905,(—):16–19. Summary in Exp. sta. rec., 1906, **18**:10.

The mean temperature for 1905 was 39.43° F., the total rainfall was 30.76 inches, the evaporation for the five months, May to September, was 26.45 inches. A comparison between the rainfall and evaporation for the corresponding periods of the years 1902–1905 shows usually an excess of evaporation, 1.96, 2.56, and 2.74 being the ratios, although in 1905 they were practically equal.

Leake, H. M.

Some preliminary notes on the physical properties of the soils of the Ganges Valley, more especially in their relation to soil moisture. Jour. agr. sci., 1906, **1**:454–69. Abstract in Exp. sta. rec., 1906, **18**:13.

The determinations of percentage of soil samples indicate a loss by evaporation equivalent to 210 tons of water per acre from October 10 to November 21, or an average daily loss of 4 tons per acre. This is thought to be much higher than the actual.

Livingston, Burton E.

The relation of desert plants to soil moisture and to evaporation. Carnegie Inst. Washington, Pub. 50. Washington, 1906. 78 p.

Studies of evaporation rates from soil and water were made at Tucson, Arizona, in the summer of 1904. It is shown that the relatively high moisture content in the deeper layers of clay soils in this region is due, in part, to the fact that the evaporating power of the air is so excessively high that the movement of the soil water can not keep the upper layers moist, and a dry mulch forms which tends to prevent further evaporation. Describes a porous clay evaporometer essentially the same as those employed by Babinet (1848), Marié-Davy (1869), and Mitscherlich (1904). It is pointed out that the evaporating power of the air can not be shown by the psychrometer, as this leaves out of account the factor of air currents. Next to an evaporometer the stationary wet- and dry-bulb thermometers, placed in the open air, are considered the most reliable instruments for estimating evaporation. The ratios between the reading of the evaporometer and transpiration from plants indicate a physiological regulation of evaporation within the plant. Comparative experiments were made with an air current at various velocities produced by an electric fan; a velocity of 4.6 meters per second increased evaporation 250 per cent, and a velocity of 8.0 meters per second increased it 450 per cent.

Luedecke, Carl.

Das Verhältniss zwischen der Menge des Niederschlages und des Sickerwassers. Mitt. Landw. Inst., Breslau, 1906, **3**:615–46.

Manila Central Observatory.

Meteorological data reduced from hourly observations. Phillipine Weather Bureau Bulletins, January to July, 1906. Manila, P. I.

The record of evaporation at Manila may be tabulated as follows:

Month.	Evaporation.		Rainfall.
	In sun.	In shade.	
1906.	*Mm.*	*Mm.*	*Mm.*
January	192.2	91.1	12.7
February	219.7	104.5	13.4
March	....	....	....
April	313.5	153.0	4.9
May	246.2	125.9	358.4
June	158.9	84.5	154.9
July	177.1	94.5	310.2

Mill, Hugh Robert.

Records of evaporation and percolation. Brit. rain., 1906, **46**:46–52. Rev. in Nature, 1907, **76**:587. Abst., Exp. sta. rec., 1907, **19**:711–2.

The evaporation at 11 stations averaged 18.07 inches with a rainfall of 30.15 inches. This article is accompanied by a plate showing comparative curves of evaporation and other meteorological data, as in 1905. A table prepared by David Ronald compares evaporation from sandy soil, as calculated from rainfall and percolation, with evaporation from free water surface at Cauldhame, Falkirk. The rainfall was 39.93 inches, the evaporation from sand 19.83 inches, and evaporation from free water surface, 13.51 inches. According to Latham's experiments in 1806 chalk allows less percolation and consequently greater evaporation than gravel.

Miller, N. H. J.

The amount and composition of the drainage through unmanured and uncropped land, Barnfield, Rothamsted. Jour. agr. sci., 1906, **1**:377–99.

With the aid of gages he estimates the annual evaporation from undisturbed soil during the period 1870–1905, grouping it under various amounts of rainfall.

Mitchell, F. C.

The evaporation of ice. Mo. weather rev., 1906, **34**:526–8.

Careful determinations of the loss of weight of ice, due to evaporation for short periods and at temperatures below 0°C., showed that the rate of evaporation increases with the temperature and atmospheric pressure. It is further shown that the rate is proportional to the area exposed.

Neruchev, M.

Precipitations, their income and outgo in relation to droughts. Zap. Imp. Obsch. Selsk. Khoz. Yuzh. Ross., 1906, No. 4–6. Abstract in Zhur. opuitn. agron., (Russ. Jour. exp. Landw.), 1907, **8**:119–120; Exp. sta. rec., 1907, **19**:414.

The droughts in southern Russia are attributed not to deficient rainfall, but to the high evaporation which considerably exceeds the rainfall.

Newton, William B.

The aquameter. Quart. jour. roy. met. soc., 1906, **32**:11–13. Notice in Science, 1906, **23**(N. S.):853.

A résumé of the principles of hygrometry and the use of wet- and dry-bulb thermometers. The "aquameter" is designed to show the amount of water vapor contained in a certain amount of air by measuring, by means of a mercury column, the change in pressure produced by absorbing the water vapor with phosphoric anhydride.

Praagh, L. V.

Meteorology of the Transvaal. From "The Transvaal and its Mines." London and Johannesburg. 1906. p. 90–3. Abstract, Exp. sta. rec., 1907, **19**:711.

Evaporation in the Transvaal is approximately three times the rainfall. The mean annual rainfall for 14 years at Pretoria was 26.31 inches.

Réthly, A.

Die Verdampfungsverhältnisse von Siófok. (Magyar.) Idöj. Budapest, 1906, **10**:76-8.

Savinov, S. I.

Verdunstung im Schatten. (Russian.) Met. věst., 1906, **16**:349–54.

Schwab, Franz.

Ueber die Verdunstungsmessungen in Kremsmünster. Met. Zeits., 1906, **Hann Band**:23–35.

Discusses the various methods of observing evaporation practiced at Kremsmünster from 1824 to the present time. Annual rates varying according to the exposure and instruments, from 1358.9 mm. to 228.9 mm. are recorded. Rates from other places are quoted. The daily curve of evaporation was studied with the Wild atmometer from June, 1904, to September, 1905. The ratio between the nocturnal and diurnal amounts is shown to vary with the temperature, from 2.8 mm. in June to 1.5 mm. in November. The daily maximum always occurred between 2 and 4 p. m., coincident with the temperature maximum and the relative humidity minimum.

Seelhorst, C. von.

Feuchtigkeitsverhältnisse eines Lehmbodens. Jour. Landw., 1906, **54**:187–206.

Determinations of the moisture content of the soil showed that rye used much less soil water than wheat, oats demanded a large amount of water and clover the most. Peas used a relatively small amount and potatoes the least.

Seelhorst, C. von.

Wasserverdunstung und Wasserabfluss eines gebrauchten Lehm- und Sandbodens. Jour. Landw., 1906, **54**:313–5. Abstract, Exp. sta. rec., 1907, **18**:617.

Observations of drainage and evaporation from loam and sandy soils in large vegetation tanks, from October, 1904 to March, 1906, show that evaporation was largest and drainage smallest from the loam during the fall and winter, the same being true of the sandy soils in summer. The evaporation was as a rule smaller, and the drainage larger, from the sandy soil than from the loam. Greater evaporation from the sandy soil was observed only during a period of high temperature and heavy rainfall in summer. The greater evaporation from the loam soil is attributed to slower percolation and greater capillary capacity in this soil.

Seelhorst, C. von.

Ueber den Wasserverbrauch von Roggen, Gerste, Weizen und Kartoffeln. Jour. Landw., 1906, **54**:316–42.

Careful experiments at Göttingen in 1905 on the amount of moisture used and evaporated by rye, oats, wheat, and potatoes in loamy and sandy soils.

Strachan, Richard.

Methods of estimating evaporation. Horological Journal, 1906, **48**:79–80, 95–6, 160–2, 178–80.

Compares and discusses formulas for calculating evaporation, including Mann's (1871) Fitzgerald's (1886), Weilenmann's (1877), Stelling's (1881), and Strachan's (1905).

Vernon, J. J.

Irrigation. New Mexico Exp. sta. rpt., 1906. p. 29–38. Abstract, Exp. sta. rec., 1907, **19**:384.

Evaporation for a year at the New Mexico experiment station amounted to 58 inches.

Victoria, Ernesto G.

Evaporación y frio producido por ella en Lima. Bol. soc. geog. Lima, 1906, **19**:1–58.

The construction, exposure, and method of observing the Piche evaporometer are described, together with an account of the causes which favored or retarded evaporation. The daily maximum evaporation in the sun and shade, from 1897–1905, fell usually in February or March, and the minimum in July or August. A study of the depression of the wet-bulb thermometer both in the sun and shade, shows an increase in arithmetical progression, from autumn to summer, the amount varying during the year from 0° to 10°C. Concludes that this cooling varies inversely with barometric pressure, relative humidity, and rainfall, but directly with temperature, the hours of sunshine, and the direction of the wind. Tables of all observations are presented.

1907.

Abbot, H. L.

Rainfall and outflow above Bohio, in the valley of the Chagres. Mo. weather rev., 1907, **35**:74–5. Review in Met. Zeits., 1908, **25**: 326–30.

From the difference between the rainfall and the total river flow, the average annual evaporation on the Isthmus of Panama (1898–1906), is estimated as 38.29 inches. Direct measurements by the pan method show 0.135 inches per twenty-four hours in December, 1906, 0.167 inches for January, 1907, and 0.181 inches for February, 1907. The first method gives negative evaporation for these months.

Abe, K.

On the density of snow on the ground and the evaporation from its surface. (Japanese.) Jour. met. soc. Japan, April, 1907, **26**.

Badgley, W. F.

Evaporation from the soil. Quart. jour. roy. met. soc., 1907, **33**:182.

An unsatisfactory attempt to measure the evaporation from soil by collecting on a cold surface and weighing the vapor rising from a certain area.

Barbour, Percy E.

The Salton sea. Journal of Worcester Polytechnic Institute, 1907, **10**:165–71.

An estimate of the annual evaporation from the Salton Sea based on estimates of the time and quantities of water required to fill the Salton Sink to various levels.

Bigelow, Frank H[agar].

Studies on the phenomena of the evaporation of water over lakes and reservoirs. (I) The proposed study on the problems of evaporation at the Salton Sea, California. Mo. weather rev., 1907, **35**: 311–6. Reprinted, Washington, D. C., 1907.

An account of proposed cooperative study of evaporation on a large scale at the Salton Sea by the U. S. Geological Survey, the U. S. Reclamation Service, and the U. S. Weather Bureau. Describes the conditions to be expected in the arid regions of the West, the past history and future possibilities of Salton Sea, the need for investigation of evaporation, and the present favorable opportunity for studying the phenomenon as it is occurring naturally from this large isolated water surface. The need for further research into the theory of evaporation is shown by a comparison of formulas previously developed. The formulas quoted, with the exception of Russell's, are transcribed into a uniform notation, and he endeavors to show their lack of agreement. Discusses Stefan's thermodynamic theory of evaporation, and presents the general theory of evaporation.

Boulatovitch, M. and A. Winkler.

Meteorological observations at the Ploti Experiment Station, 1907. Godĭchnuiĭ Otchet Ploty. Selsk. Khoz. Opuitn. Stantziĭ, 1907, **13**: 1–53, 161–7. Exp. sta. rec., 1909, **20**:616.

The total evaporation for 1907 was 28.3 inches, the average annual for 13 years was 32.5 inches. The rainfall for 1907 was 11.37 inches, the average annual for 13 years being 16.26 inches. The mean relative humidity for 1907 was 70 per cent, and the average temperature 7.8°C.

Buckingham, E. and F. K. Cameron.

Studies on the movement of soil moisture. U. S. Bur. Soils, Bul. 38. Abstract, Exp. sta. rec., 1907, **18**:820.

Evaporation from points below the surface of soils in tumblers or small cylinders, under various conditions, while measureable is quite small and negligible in comparison with the losses taking place at or very near the surface. A comparison of loss of water from a soil under arid and humid conditions shows it to be much more rapid at first under the arid conditions, so rapid "as to overtax the soil's ability to move water from within to the surface by capillarity." A dry layer is therefore formed which keeps the losses far below those from the soil under humid conditions where the capillary flow to the surface presists until the moisture content of the whole soil is very low.

Cameron, F. K.
See Buckingham, E. and F. K. Cameron.

Fritzsche, R.
Niederschlag, Abfluss und Verdunstung auf den Landflächen der Erde. Zeits. Gewässerk., 1907, 8:74.

Gravelius, Harry.
Untersuchungen zur Abflussfrage. Zeits. Gewässerk., 1906, 8:15–37.

Hoyt, John Clayton and Nathan Clifford Grover.
River discharge. New York. 1907.

The authors declare that the difference between the annual rainfall and run-off represents very closely the annual evaporation. Evaporation influences both the total and the seasonal flow of streams. The annual evaporation from water surfaces is estimated as varying from 20–40 inches in the humid Eastern States to 70–100 inches in the arid West. Discuss briefly the effect of the character of the soil and vegetation on evaporation.

Keeling, B. F. E.
The climate of Abbassia near Cairo. Cairo. 1907. Review in Met. Zeits., 1908, 25: 458–60.

Evaporation was measured at the observatory at Abbassia by means of a Wild evaporometer placed in the thermometer shelter. The average monthly amounts for the years 1900–1903 varied from 45 millimeters in January to 214 millimeters in June; the annual average was 1577 millimeters.

Knoche, Walter.
Die Verdunstungs- und Kondensation-Grenze an der Wolkenoberfläche. Met. Zeits., 1907, 24: 369–71.

A mathematical discussion of the relations between condensation on and evaporation from the surface of clouds.

Ladd, E. F.
Evaporation from water surfaces. North Dakota Exp. sta. rpt., 1907, pt. 1, p. 33–6. Abstract, Exp. sta. rec., 1909, 20: 515.

This report contains, according to the Experiment station record, "a record of observations on evaporation from the surface of water contained in a galvanized iron tank, the evaporation during 1907 being compared with that of five previous years and with the rainfall during the same period."

Livingston, Burton E.
Evaporation and plant development. Plant world, 1907, 10: 269–76. Abstract, Exp. sta. rec., 1908, 19: 1024–5.

Describes a simplification of his evaporometer (see 1906) for general ecological and physiological work. Discusses an experiment which shows that the evaporating power of the air may be so high that the rate of transpiration exceeds the rate of moisture supply, even though the soil be kept well watered.

Luedecke, Carl.
Das Verhältniss zwischen der Menge des Niederschlages und des Sickerwassers nach Englischen Versuchen. Kulturtechniker, 1907, 9: 101–26.

Merriman, Thaddeus.
Rainfall and run-off of the Catskill mountain region. Mo. weather rev., 1907, 35: 109–18.

Enumerates and discusses (p. 114–5) the general laws of evaporation over large districts, and calculates the percentage of rainfall evaporated over the Croton, Pequanac, and Sudbury watersheds under various temperatures.

Merz, Alfred.
Beiträge zur Klimatologie und Hydrographie Mittelamerikas. Mitt. Verein Erdk., Leipzig, 1906, (—):——. Reprinted Leipsic, 1907. 96 p. 3 Pl. Review in Met. Zeits., 1908, 25: 326–30.

An elaborate discussion of the rainfall and run-off in various regions of Central America. Evaporation is considered equal to the rainfall minus the run-off. The annual amount of evaporation from Managua Lake is reported as 1,575 millimeters, with a rainfall of 1,185 millimeters, and from Nicaragua Lake the figures are respectively 1,309 and 1,599 millimeters. In the flood region of the San Juan the rainfall varies from 1,709 to 3,263 millimeters, with corresponding evaporation rates of 1,177 and 1,110 millimeters. The reviewer considers that the observations on these lakes probably give greater amounts than the reality, and finds it interesting to compare these numbers with the fantastic amounts, up to 7 meters a year, which were formerly assumed for tropical oceans.

Mill, Hugh Robert.
Records of evaporation and percolation. Brit. rainf., 1907, 47: 44–51.

The usual data are given. The accompanying plate presents comparative curves of evapo-

ration and other meteorological data, as in 1905 and 1906, including the record of a new instrument, the Wilson radio-integrator. The curve made by this instrument closely resembles that of evaporation from an exposed water surface during August and September, but during November and December it is quite characterless. The evaporation curve follows those of duration of sunshine and black-bulb temperature in summer, and those of mean temperature of water and soil at 1 foot depth in winter. The curve of wind velocity here seems to have very little relation to that of evaporation. Latham's tables, Hall's at Rothamsted and Ronald's at Cauldhame, Falkirk, are included.

Rykachev, M.
(New evaporometer for observing evaporation from grass, and the first observations with this instrument at the Constantine Observatory in 1896.) Mém. acad. imp. sci., St. Petersburg, phys.-math. Cl., **7** (sér. 7), No. 3.

Stevens, J. S.
Meteorological conditions at Orono, Maine. Univ. Maine Studies, No. 7. 52 p. Chart 1. Abstract, Exp. sta. rec., 1907, **19**: 311.

Includes results of a series of special observations on the evaporation of snow, ice, and liquids.

Summers, W. L.
Semi-arid America, its climate compared with that of South Australia. Jour. dept. agr., So. Aust., 1907, **10**: 411–4. Abstract in Exp. sta. rec., 1907, **18**: 1022–3.

The evaporation in the semi-arid regions of America is said to be less than in those of South Australia.

Sutton, J. R.
A contribution to the study of evaporation from water surfaces. Sci. proc. roy. Dublin soc., 1907, **11** (N. S.): 137–78. Abstract in Exp. sta. rec., 1907, **19**: 617–8.

The amount evaporated at Kimberley from a Piche evaporometer was 84.48 inches, and from a screened metal vessel, 14 inches in diameter and 18 inches deep, 65.94 inches.

Tinsley, J. D.
Forty years of southern New Mexico climate. New Mex. Exp. sta. bul., No. 59. Abstract in Exp. sta. rec., 1907, **18**: 611. Review in Bul. Am. geog. soc., 1907, **39**: 419.

The evaporation in this region is given as 5 to 6 feet per year.

Todd, Sir Charles.
Meteorological observations made at the Adelaide Observatory and other places in South Australia and the Northern Territory during the year 1905. Adelaide. 1907. Review in Met. Zeits., 1908, **25**: 478–9.

The results obtained by Sir Charles Todd show a monthly average evaporation, for the years 1870–1904, varying from 32 millimeters in June to 225 millimeters in January; the average annual evaporation is 1,396 millimeters.

Wilcox, Lucius N.
Irrigation Farming. New York. 1907.

On pp. 149 and 464, the relation of evaporation to agriculture, especially in the arid regions, is treated, with estimates of amounts evaporated daily from canals and reservoirs.

Winkler, A.
See Boulatovitch, A. and A. Winkler.

1908.

Bigelow, Frank H[agar].
Studies on the rate of evaporation at Reno, Nev., and in the Salton Sink. Nat. geog. mag., 1908, **19**: 20–8.

The author describes the Salton Sea and its origin. It has been generally supposed that the depth of the annual evaporation from the surface of this sea is as much as 8 feet, but the author believes, on the basis of experiments made at Reno, Nev. (cf. next entry), that it may not be more than 4 or 5 feet.

Bigelow, F[rank] H[agar].
Studies on the phenomena of the evaporation of water over lakes and reservoirs. II. The observations on evaporation made at the reservoir in Reno, Nev., August 1 to September 15, 1907. III. Discussion of the observations made at Reno, Nev., August 1 to September 15, 1907. Mo. weather rev., 1908, **36**: 24–39, Charts 17–27. Reprinted, Washington, D. C., 1908.

The author describes the Reno, Nev., reservoir, the general conditions of the experiments, and the methods of observing. He calculates tables of vapor pressure and evaporation at Reno, Nev., August 1–10, 12–17, 1907. Five towers were erected for the purpose of studying evaporation and the phenomena most closely related to it. These towers were located on an east and west line crossing both basins of the reservoir, and exposed to conditions ranging from arid, over an unirrigated field, to humid over an irrigated alfalfa field. Twenty-nine galvanized-iron pans were employed. Three 6-foot pans were floated in water at the foot of towers 2, 3, and 4, two others were on the ground at the foot of towers 1 and 5. Pans 2 feet in diameter were placed on the towers at levels of 0, 2, 7, 15, 25, 35, and 45 feet. Sling and floating psychrometers [see Marvin, 1909, 3d title] were used to find the temperatures and vapor pressures in and near the pans. The level of the water was read by means of a vertical scale tube. Readings were taken of all the instruments every three hours from 5 a. m. to 8 p. m., and also at 1 a. m. The author concludes that "the location of the pans relative to the water of a reservoir is of primary importance in measuring the total amount of evaporation and that observations on a pan away from the water can not be transferred to the water surface itself, except with the utmost caution." The observations show the existence of a vapor blanket extending some 30 feet above the surface of the reservoir, and a similar, but less perfect blanket, over the alfalfa field.

The author develops the following formula:

$$E = Cf(h)\, e \frac{de}{ds} (1 + Aw),$$

where $E=$ evaporation, $h=$ height above water surface, $e=$ vapor pressure at the dew-point, $de/ds=$ rate of increase of vapor pressure with rise of temperature, $A=$ a constant modifying the wind, $w=$ wind velocity in kilometers per hour, and $Cf(h)=$ a complex variable depending on h. In a summary the author describes a modified form of the Piche atmometer, which it had been hoped could ultimately be substituted for the large pans. A general conclusion is that the vapor blanket above the reservoir seems to conserve about $\frac{3}{8}$ of the water that would otherwise be lost by evaporation.

Boname, P.

Meteorology. Sta. agron. Mauritius, Bul., **16**:1–15. Abstract, Exp. sta. rec., 1908, **20**:212.

Presents records of evaporation in Mauritius during 1906 and 1907.

Brückner, Eduard.

Niederschlag, Abfluss, und Verdunstung auf den Landflächen der Erde. Met. Zeits., 1908, **25**:32–5. Abstract, Exp. sta. rec., 1908, **20**:114.

The author compares estimates made by various writers, of total rainfall, runoff, and evaporation on the land surfaces of the earth. Points out that over the water surface of the earth evaporation exceeds precipitation, but that 92 per cent of the moisture evaporated falls again upon the water surface of the globe. Over the lands evaporation is decidedly less than precipitation, about 2 : 3. About 70 per cent of the precipitation on the land surface is derived from evaporation from the land.

Day, F. H.

Deficient humidity. Mo. weather rev., 1908, **36**:404–6.

In course of studies on the physiological effects of indoor aridity the author carried out several comparisons between the indications of various instruments for determining dew-point and vapor pressure, viz, chemical analysis, stationary wick-psychrometer, Regnault hygrometer, and the whirled psychrometer. He finds a close agreement between the results by the chemical method and the whirled psychrometer, and Regnault's dew-point apparatus.

Etna Observatory.

Meteorologische Beobachtungen zu Catania, 1892 bis 1905. Met. Zeits., 1908, **25**:137-8.

Observations by A. Ricco and Cavasion, at the base station of the Etna Observatory show a monthly evaporation varying from 1.80 centimeters in January to 5.55 centimeters in July, with an average monthly total of 3.27 centimeters.

Gager, C. Stuart.

The evaporating power of the air at the New York Botanical Garden. Mo. weather rev., 1908, **36**:63–4. Abstract, Exp. sta. rec., 1908, **19**:1010–11.

Experiments to determine the evaporating power of the air were carried on at the New York Botanical Garden from June 10 to October 14, 1907. Employed three different Livingston evaporometers which gave results varying from 4.84 to 12.10 inches according to exposure. The rainfall for the period was 9.32 inches. The difference between rainfall and evaporation is regarded as an index of the evaporating power of the air for the given station.

Hall, A. D.

The Soil. An introduction to the scientific study of the growth of crops. New York. 1908.

In a chapter on tillage and the movements of soil water the author points out the effect of cultivation in checking evaporation from the soil.

Livingston, B[urton] E.

A simple atmometer. Science, 1908, 28(N. S.):319-20.

Illustrates a modification of the evaporometer described in 1906. The indications of any one instrument must be corrected by a coefficient obtained by comparing it with a standard instrument. Recommends this instrument for studies dealing with the relations between meteorological conditions and plant growth.

Livingston, Burton E.

Evaporation and plant habitats. Plant World, 1908, 11:1–9. Review, Exp. sta. rec., 1908, 19:1025.

A study of the evaporating power of the air in several plant habitats at St. Louis and Columbia, Mo., leads to the conclusion that the marked differences in the weekly rates, as indicated by Livingston evaporometers, may furnish a measure of the conditions controlling the character of the vegetation. The weekly rates of several evaporometers exposed at altitudes between 2,412 and 8,000 feet in the neighborhood of Tucson, Ariz., showed a decrease from 298 to 133 cubic centimeters.

Livingston, Burton E.

Evaporation and centers of plant distribution. Plant World, 1908, 11:106–12.

The author discusses the relation between the evaporating power of air to the geographic distribution of vegetation in the United States. "To test the value of evaporation alone as a criterion for relating plant distribution to climatology" porous cup evaporometers of the pattern described above [first paper], were exposed at a number of places in the United States. The resulting weekly rates for seventeen weeks, June 3 to September 30, 1907, are to be considered "only as relative measures of the evaporating power of the air." Grouping the results according to the plant centers represented, when the evaporation for the conifer region is taken as unity, the deciduous forest center becomes 1.15 and the deserts of the southwest, 2.86. These number are found to form a series similar to that obtained by Transeau (1905). The author concludes that the evaporating power of the air offers a promising criterion for relating vegetational centers to climatic factors.

Norton, J. H.

Quantity and composition of drainage water and a comparison of temperature, evaporation, and rainfall. Jour. Amer. chem. soc., 1908, 30: 1186–90. Abstract, Exp. sta. rec., 1909, 20: 814–15.

Studies in the drainage basin of Richland Creek, Madison and Washington counties, Ark., showed that during the growing season evaporation was more than 90 per cent of the rainfall, and the ratio for the whole year 70 per cent.

Schubert, [Johannes].

Der Wasserhaushalt an der Erdoberfläche. Met. Zeits., 1908, 25: 415–6.

In a paper before the Dresden Geographical Society on the relations between rainfall and evaporation, Schubert states that a long English record of the percolation through soil shows the evaporation is about one-half the rainfall. Brückner and Fritsche are cited as authorities for the statement that the total annual evaporation from the land surfaces of the globe averages 61 centimeters and the rainfall 87 centimeters. For the districts with no run-off the two phenomena are considered to balance each other at 33 centimeters. Keller's still closer estimate for middle Europe gives average evaporation for the years 1851–1890, 44.6 centimeters with a rainfall of 26.8 centimeters.

Sprung, A.

Die registrierende Laufgewichtswage im Dienste der Schnee-, Regen- und Verdunstüngsmessung. Met. Zeits., 1908, 25: 145–54.

Describes a self-registering sliding weight balance for measuring snow, rain, and evaporation, and presents tables and register curves.

Transeau, Edgar N.

The relation of plant societies to evaporation. Bot. gaz., 1908, 45: 217–31. Abstract, Exp. sta. rec., 1908, 20: 224.

From his efforts to obtain quantitative measurements of the various environmental factors influencing plant societies, the author concludes that comparative evaporation data "would be far more valuable than the usual temperature and relative humidity readings." The instrument used for measuring this factor was the porous cup atmometer described by Livingston (1908). The standard instrument placed in the garden of the Station for Experimental Evolution, Long Island, N. Y., evaporated 1,657 centimeters during twelve weeks, May 20 to August 11, inclusive. Other instruments evaporated, according to environment, from 10 per cent to over 120 per cent of the amount given off by the standard instrument. The author considers that the use of this instrument will be of the greatest importance in the study of habitat conditions, since its surface is constant and continually exposed in the same way, thus furnishing data which may be directly related to the plant.

Voeikov, Alexander.

The study of evaporation. Mo. weather rev., 1908, 36: 63.

The author suggests that the discrepancies between the various formulas for evaporation which were pointed out by Bigelow (1907) may be due to the fact that the anemometers are usually placed higher than the evaporometers. Local conditions of exposure may so dis-

turb the relations that coefficients deduced from one set of observations will give smaller values than another set for the same wind velocity. A table of results obtained at Pinsk and Vasilivichi (June to September, 1897) is given as a case in point. The monthly amount at the former place varied from 34.5 millimeters in September to 71.4 millimeters in June, and at the latter place from 52.9 millimeters in September to 96.6 millimeters in June.

Ward, Robert DeCourcy.

The relative humidity of our houses in winter. Boston surg. and med. jour., 1900, March 1. Reprinted in Jour. sch. geog., 1902, **1**: 310–17. Abstract, Mo. weather rev., 1908, **36**: 281–3.

This is a series of comparative observations on the relative humidity within and without a hot-air heated house in Cambridge, Mass. The author shows that the air within such a house in winter is usually as arid as the air of the deserts of the globe, and sometimes even exceeds this. He comments on the physiological effects of the sudden transition from the arid indoors to the usual winter outdoors. Doctor Barnes' table of similar observations in the hospitals of Boston is added.

1909.

A[bbe], C[leveland].

The psychrometer: Rotated, whirled, ventilated. Mo. weather rev., 1909, **37**: 23.

Emphasizes the necessity for accurate instrumental determinations of the relative humidity in biological investigations. Compares the relative accuracy of results obtained by means of the O'Gara (1909) rotation psychrometer, the sling psychrometer, and the Assmann aspiration psychrometer. A high grade of thermometer is necessary in psychrometric work, and the reduction tables must be adapted to the style of thermometers used.

Jefferson, M[ark] S. W.

Winter aridity indoors. Jour. sch. geog., 1902, **1**:... Reprinted, Mo. weather rev., 1909, **37**: 62–3.

The author, stimulated by Ward's paper (see 1908), calculates the actual volume of water which should be evaporated by a heating and ventilating plant and added to the warm air in order to preserve a healthful indoors humidity during the winter. He finds that each individual may require from 3.7 quarts up to as much as 13.7 quarts daily to properly moisten air derived from outdoors and raised to 70° F. by the heating plant of the house. A schoolhouse would need 200 gallons daily for each 100 pupils sheltered, under the average conditions described by Ward (1908).

Marvin, Charles Frederick.

The pressure of saturated vapor from water and ice as measured by different authorities. Mo. weather rev., January, 1909, **37**: 3–9, chart **37**–11, XI.

This paper reviews and compares vapor pressure measurements, formulas, tables, etc., by Regnault, Broch, Juhlin, Marvin, Thiessen and Scheel, Ramsey and Young, Battelli, Cailletet and Colardeau, Holborn-Henning, Ekholm, Landolt and Börnstein, Wiebe and others. It also gives a short bibliography.

Marvin, Charles Frederick.

A proposed new formula for evaporation. Mo. weather rev., February, 1909, **37**: 57–61.

The author points out the fundamental faults in the evaporation formulas commonly employed, and proposes the form of equation

$$dF/dt = C/B.\ (e_s + e_a - 2e_d)\ f(e)\ f(v),$$

where C=constant, B=barometric pressure, e_s, e_a, e_d,=vapor pressures corresponding to water surface temperature, air temperature, and dewpoint temperature respectively, $f(e)$= function of the vapor pressure to be evaluated by the observations, as also $f(v)$, depending on the wind effects.

Marvin, Charles Frederick.

Methods and apparatus for the observation and study of evaporation. Mo. weather rev., April, May, 1909, **37**: 141–6, 182–91.

Part I discusses methods, formulas, etc. Part II describes and illustrates instruments and apparatus for measuring and automatically recording evaporation chiefly from pans.

O'Gara, P[atrick] J.

A portable rotation psychrometer. Mo. weather rev., 1909, **37**: 22–3.

Describes a form of whirled psychrometer improvised by attaching two spherical-bulbed thermometers to opposite sides of one dasher of the ordinary egg beater, and removing the other dasher. The gears give a linear velocity of 25 feet per second and the steel dasher serves as an admirable protection for the thermometers, while the whole apparatus can be safely and accurately placed where the observations are particularly desired.

ADDENDA.

1787.

Saint-Lazare, Bertholon de.

De l'éléctricité des météores. Paris. 1787. 2 vol. 8vo.

In vol. 2, p. 84–99, he discusses evaporation.

1891.

Marvin, Charles Frederick.

Report of vapor pressure measurements and normal barometer construction. Pt. I.—Maximum pressures of aqueous vapor at low temperatures. Ann. Rpt. Chief Signal Officer for 1891, (App. 10). Washington. 1892. 8vo. p. 351–383.

Special precautions were observed in this work to eliminate errors due to the use of impure water, the presence of air in the space occupied by the vapor, and on account of unequal capillary action. Water previously freed from air by boiling was finally distilled in a vacuum at a temperature but slightly above freezing. The pressure was measured in highly exhausted U-tube mercury manometers 25 to 30 millimeters in diameter. The results brought out the distinct difference between vapor pressures over ice and over water subcooled as much as 20 Fahrenheit degrees below freezing, but yet retaining its liquid state. The observations were carried to —60° F., and a limited number of measurements were made between 32° and 80° F.

Juhlin, Julius.

Bestimning af Vattenångans Maximi-spänstighet öfver is mellan 0° och —50° C., samt öfver flytande Vatten mellan +20° och —13° C. Bihang till K. Svenska Vet.-Akad. Handlingar. Band 17, Afd. I, No. 1. Stockholm. 1891. Abstract, Met. Zeits., 1894, **11**: 98–9.

This investigation into the vapor pressures of water vapor over ice between 0° and —50° C., and over water between +20° and —13° C., gave Juhlin results closely concordant with those obtained simultaneously by Marvin, 1891. Juhlin and Marvin worked simultaneously and by very similar methods, but independently and in ignorance of each other. Juhlin presented his results to the Royal Swedish Academy of Sciences on February 11, 1891, and Marvin reported his to the Chief Signal Officer, U. S. A., on June 30, 1891. (See Marvin, 1909, first title.)

SUPPLEMENTARY

LIST OF ABBREVIATIONS FOR TITLES OF PERIODICALS.

Abh. k. bayer. Akad.. Wiss., math.-phys. Kl.	Königlich-bayerische Akademie der Wissenschaften, Mathematisch-physikalische Klasse. Abhandlungen. Munich.
Ann. met. ital........	Annali della meteorologia Italiana. Modena.
Ann. obs. Montsouris .	Annales de l'observatoire météorologique municipale de Montsouris. Paris.
Ann. soc. met. ital....	Annuario della società meteorologiche italiana. Turin.
Atti. r. ist. sci., Naples,	Atti della reale istituto d'incoraggiamento delle scienze naturali, economiche, e technologiche. Naples.
Beibl. Ann. Phys. und Chemie.	Beiblätter der Annalen der Physik und Chemie. Leipsic.
Beitr. Geophysik. Leipsic.	Beiträge zur Geophysik. Zeitschrift für physikalische Erdkunde. Zugleich Organ der Kaiserlichen Hauptstation für Erdbeben-forschung zu Strassburg i. E. Leipsic.
Ber. Deut. Naturf.....	Amtliche Berichte über die Versammlungen Deutcher Naturforscher und Aerzte. Leipsic.
Ber. Phys. Med. Soc..	Verhandlungen der physikalisch-medezinischen Societät zu Erlangen. Continued as Sitzungsbericht.
Bot. gaz............	Botanical Gazette. Chicago.
Bul. Amer. geog. soc.	Bulletin of the American geographical society. New York.
Bul. cent. met. obs. Japan.	Bulletin of the Central meteorological observatory, Tokyo, Japan. Tokyo.
Centbl. Agr. Chem. (Biedermann).	Biedermann's Central-Blatt für Agrikulturchemie und rationellen Landwirtschafts-Betrieb. Leipsic.
Comment. Ateneo, Brescia.	Commentari dell' Ateneo di Brescia. Brescia.
Godīchnuiĭ Otchet Ploty. Selsk. Khoz. Opuitn. Stantziĭ.	Godīchnuiĭ Otchet Plotyanskoĭ Selsko-Khozyaĭstvennoĭ Opuitnoĭ Stantziĭ. (Annual report of the Ploty agricultural experiment station). Odessa.

Jour. met. soc. Japan,	Journal of the meteorological society of Japan. Tokyo.
Jour. Scot. met. soc...	Journal of the Scottish meteorological society. Edinburgh.
Kulturtechniker......	Der Kulturtechniker. Breslau.
Landw. Vers. Sta.....	Die Landwirtschaftlichen Versuchs-Stationen. Berlin.
Mém. acad. imp. sci., St. Petersburg, phys.-math. cl.,	Mémoires de l'academie imperiale des sciences de St. Petersbourg.
Mem. accad. sci., Bologna.	Accademia delle scienze dell'istituto di Bologna. Memorie. Bologna.
Mém. soc. agric., Bayeux.	Société d'agriculture, sciences, arts, et belles lettres. Mémoires. Bayeux.
Met. council rpt......	Report of the Meteorological Council to the royal society, for the year ending March 31. London.
Min. proc. intercol. met. conf.	Minutes of the proceedings of the intercolonial meteorological conference at Melbourne.
Mitt. Landw. Instit..	Mittheilungen der Landwirtschaftlichen Institut der königlichen Universität Breslau. Berlin.
Mitt. Verein. Erdk., Leipsic.	Mittheilungen des Vereins für Erdkunde zu Leipzig. Leipsic.
Naturw. Runds.......	Naturwissenschaftliche Rundschau. Brunswick.
Nebr. exp. sta. bul...	Bulletin of the Nebraska experiment station.
Natkdg. tidjsch. Ned. Ind.	Naturkundig Tijdschrift voor Nederlandsch Indie. Batavia.
Naturforscher, Berlin.	Der Naturforscher. Wochenblatt zur Verbreitung der Fortschritte in der Naturwissenschaften, Berlin.
Petermann's Mittheil.	Petermann's Mittheilungen aus Justus Perthes' Geographischer Anstalt. (Supan). Gotha.
Plant World.........	The Plant World. Tucson, Ariz., and Washington, D. C.
Rend. accad. sci., fis. math. sez., Naples.	Rendiconti dell' academia delle scienze fisiche e mathematiche sezione della Società Reale di Napoli. Naples.
Rpt. Australasian assoc. adv. sci.	Reports of the Australasian association for the advancement of science.
Rpt. So. African assoc. adv. sci.	Reports of the South African association for the advancement of science.
Selsk. Khoz. ī Lyesov.	Sel'skoe Khozyaĭstvo ī Lyesovodstvo (Rural Economy and Forestry). St. Petersburg.
Sta. agron. Mauritius, Bul.	Colony of Mauritius Station agronomique. Bulletin. Mauritius.
Trans. roy. soc. arts, sci, Mauritius.	Société royale des arts et des sciences de l'île Maurice. Transactions. Port Louis, Mauritius.
U. S. Bur. Soils, Bul..	U. S. Department of Agriculture. Bulletins of the Bureau of soils.
Verhdl. Deut. phys. Gesellsch.	Verhandlungen der Deutschen physikalischen Gesellschaft. Berlin.
Versuchsstat. Org.....	Die Landwirtschaftlichen Versuchs-Stationen. Berlin.
Zap. Imp. Obshch. Selsk. Khoz. Yuzh. Ross.	Zapīskī Imperatorskagho Obshchestva Selskagho Khozyaĭstva Yuzhnoĭ Rossiī. (Memoirs of the imperial society of rural economy of southern Russia.) Odessa.
Zeits. Kolonialpol., Berlin.	Zeitschrift für Kolonialpolitik, Kolonialrecht und Kolonialwirtschaft. Berlin.

1908.

Bigelow, F. H.

Studies in the phenomena of evaporation of water over lakes and reservoirs. IV.—The progress of the research in 1908, and the proposed campaign for the years 1909 and 1910. Mo. weather rev., 1908, **36**:437-445.

After a brief statement of the extension of the net of evaporation stations and the plans for the observations at these, the author goes on to a brief analysis of his theory and his second formula for discussing evaporation observations. This second formula is

$$E_0 = C_d \times 0.100 \frac{e_s}{e_d} \cdot \frac{de}{dS} (1 + Aw).$$

employing the same notation as above. He gives examples of computations by this formula, and also of how he would abbreviate the extensive computations it involves, by means of certain mean daily values.

The C_d-coefficients for Reno, Nev., Indio and Mecca, Cal., are then compared. It appears that while the above formula eliminates the vertical variations of this coefficient at any one locality, it yet varies from station to station. The 1909 campaign is designed to aid in explaining this variation. A set of special observations at the Indio, Cal., railroad station showed how results may vary even under identical meteorological conditions, simply as the result of differences in the positions and sizes of contiguous pans. These campaigns are regarded as preliminary ones, designed to develop the problems to be solved.

CORRIGENDUM.

1896.

Schierbeck, N. P.

Sur la vitesse de l'évaporation au point de vue spécial des relations physiologiques. Overs. k. Danske Forhandl., 1896, No. 1, 30 p. Abstract in Fortsch. der Phys., 1896, **25**, pt. ii:308-9.

Investigates the relation between rate of evaporation and the condition of the atmosphere, using the formulas of Dalton and Stefan; his experiments confirm the Stefan formula. He finds the coefficient of evaporation directly proportional to the absolute temperature. The volume of vapor passing through a cross section of unit area in a unit of time at a temperature of 0° C. and pressure of 760 millimeters is expressed by the equation

$$v = K/h . \log \frac{B-f}{B-f_1},$$

where B = air pressure, h = height of the pan's rim above the water surface, f = vapor pressure at temperature of the air, f_1 = vapor pressure at the temperature of evaporation, K = constant.

Also finds that the evaporation is proportional to the square root of the rate of boiling; and that the difference $f-f_1$ is not a measure of the rate of evaporation. The drying power of a climate is expressed by

$$\log \frac{B-f}{B-f_1} (1 + \alpha t) w^{\frac{1}{2}},$$

f_1 to be measured by the highest grade thermometers, w = wind velocity.

[Reprinted from Monthly Weather Review, 1908, **36**: 181-186; 301-306; 375-381. 1909, **37**: 68-72; 103-109; 157-160; 193-199; 248-252.]

AUTHORS INDEX.

GEOGRAPHIC INDEX.

(Localities for which evaporation data are given or referred to.)